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On Symbols for Units of Measurement

VARIOUS standardizing and publication agencies in the sciences and engineering have recommended or adopted lists of "abbreviations" for the names of units of measurement. None of the lists, even the most recent ones, seem to have been compiled with much regard for the view that these "abbreviations" may be usefully employed as *physical symbols*, in the sense that they may be incorporated in physical equations in exactly the same manner as are the letter symbols for physical quantities and the numerical symbols; moreover, that these symbols (abbreviations) are then subject to the same conventions and rules of operation as are the other mathematical symbols of physical science. For this view to hold, a letter symbol for a physical quantity must be interpreted as representing both the magnitude and unit of the quantity; for example, $V = 4$ ft^3. It is true that the letter symbols may be regarded alternatively as representing magnitudes alone; thus, V (in cubic feet) $= 4$. Either one of the interpretations may be adopted so long as one uses it exclusively throughout a particular physical description.

No single list of unit-symbols will be generally useful, however, unless it is devised mainly in the light of the first interpretation and its implications; for this interpretation, unlike the second one, suggests that considerable economy of thought can be effected if the rules for selecting and using unit-symbols are formulated, not mainly arbitrarily, but in the light of already established mathematical procedures. As an analogy, consider an earlier time when negative exponents had not yet been defined and there were no rules for operating on quantities such as x^{-n}. If standardization had been the only issue, any one of several definitions agreed upon by a majority might conceivably have served. However, a definition and rules of operation for positive exponents were already available, and so the sensible step was to adopt $x^{-n} \equiv 1/x^n$ as the definition, thus making factors involving negative exponents subject to the same rules of operation as those with positive exponents. Integrative steps of this kind, which effect economy of thought and effort, and simplify learning, are of course a main objective of any science.

In line with these ideas, we prepared a 35-page mimeographed document on unit-symbols and sent it to a number of physicists in various types of educational institutions and industrial and Government laboratories. Included in the document was a proposed set of rules applying to such symbols and a list of approximately 500 primary and secondary units, together with the various "abbreviations" for each of them that are in more or less common use. In the light of the various comments and criticisms received, the statement and list were prepared that appear on page 1078 of this issue. Many of the units listed in the original document have been eliminated, the present Table 1 being confined to those basic units and combining forms that are believed to be in most common use.—D. R.

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Conditioning and Generalization of Unconscious Anxiety

John I. Lacey and Robert L. Smith

Fels Research Institute for the Study of Human Development, Yellow Springs, Ohio

THIS is a report of the first of a series of experimental studies of unconscious anxiety (*1*). Both terms in this concept need definition within the context of this study, which uses the methods of Pavlovian conditioning as an experimental tool.

Anxiety. Schoenfeld (*2*) has ably presented an argument for using conditioning to a painful stimulus as the laboratory approach to the study of anxiety. Anxiety is defined simply by the behavioral changes that follow a signal of forthcoming painful stimulation.

In our experiment, a spoken word is followed by electric shock. As a word and shock are repeatedly paired, evidence of increased disturbance of heart rate, digital blood flow, and sweat gland activity appears in the interval between the presentation of the word and the shock. These physiological changes that occur in anticipation of the shock constitute an operational description of a "state of anxiety."

Unconscious conditioning. The nature of conditioning in human beings is inexplicable without reference to their attitudes and cognitions, as a growing volume of experimental studies attests. This is not the place to review these experiments. A complete bibliography may be secured by referring to Hilgard and Marquis (*3*), Haggard (*4*), and Razran (*5, 6*). Razran, in particular, in his extensive investigations of salivary conditioning, which he has recently reviewed (*6*), has shown the importance of cognitive and attitudinal factors and the ease with which conditioned responses may be formed without the subject's awareness. Unfortunately for our purposes, Razran has not worked with noxious stimulation, nor has he presented data on just what his subjects' levels of awareness were.

In the present study "unawareness" means simply this: the subjects, despite intensive questioning subsequent to the conditioning session, could not report that they knew when the electric shock was coming. They could not use their language mechanisms to identify correctly the conditioned signal.

Our first experimental problem is to determine whether human subjects can develop a conditioned anxiety reaction with this degree of unawareness. Previous experiments have shown, as Miller (*7*) puts it, that "the threshold of awareness is higher than the threshold of discrimination," a phenomenon later called *subception* by Lazarus and McCleary (*8*). Miller also reviews some relevant experiments and points out that unconsciousness or unawareness is of several kinds, which may be fruitfully separated for experimental purposes. In our experiments all stimuli are supraliminal. It is the *relationship* between the conditioned and unconditioned stimulus of which the subject is unaware.

The second aim of this experiment is to study the extension of such unconscious conditioned anxiety reactions to new word-stimuli that have not themselves been paired with painful stimulation. This is the problem of semantic generalization.

Semantic generalization of conditioned responses. A conditioned response will appear, not only to the conditioned stimulus, but also to other stimuli meaningfully related to the conditioned stimulus. For example, if a conditioned salivary or skin resistance response is established to the word *style*, generalization will be found both to the homophone *stile* and the synonym *fashion* (*9*). Critical reviews of the experiments in this area have been presented recently by Razran (*10*) and Osgood (*11*).

Razran (*12*) has demonstrated such word-to-word generalizations of salivary responses conditioned to nonpainful stimuli for a wide variety of semantic relationships. His findings constitute the basis for expecting semantic generalization of an unconscious conditioned anxiety response.

Such is the general background of the present investigation. Two experiments, however, are its direct precursors. Both purport to show that unconscious conditioned anxiety responses may be produced in human subjects, but both studies are open to question.

Diven's experiment. Diven's pioneering experiment (*13*) provides the basic technique of our study. Diven concluded from his experiment that subjects could be unconsciously conditioned to the word *barn*, and that this response generalized to other rural words.

Diven measured skin resistance changes at the time shock was administered, and not during the interval between word and shock, during which time subjects chain-associated to the stimulus word. This, of course, means that the important anticipatory responses were not studied, and that Diven's data are not applicable to the study of anxiety as defined in our experiments.

Because of this technique of measurement, the response to the word *barn* could not be separated from the response to the electric shock. Diven therefore sought evidence for conditioning in the responses made during the second or extinction session, in which, unknown to the subjects, *barn* was not to be followed by shock. He grouped together the percentage ohmic changes occurring at the time shock would have been administered—itself a basic measure that does not

meet today's more exacting requirements (*14*)—of all subjects and for all presentations of the critical word in the extinction session. The same procedure was followed for a so-called "control" group, which had received *no shocks at all*. The fact that the experimental subjects showed greater autonomic reactivity to the word *barn* than did the "control" subjects was taken as proof that a true conditioned response had been formed. This conclusion is invalid in the absence of a demonstration that the experimental group's reactivity to all words was not greater than the control group's. Experience in measuring autonomic responses suggests, and experimental studies of what has come to be known as pseudo-conditioning and sensitization strongly indicate, that the lack of shock in the "control" group may have resulted in greatly diminished autonomic reactivity to all words.

Diven's study of generalization is more acceptable, in that reactions of shocked subjects to urban and rural words were compared. These reactions, however, were also measured at the end of the word-shock interval. Anticipatory autonomic responses, then, were again not evaluated. It must be concluded that Diven's experiment provides no evidence of unconscious conditioned anxiety, in the sense of this paper.

Haggard's experiment. Haggard's study (*4*) utilized Diven's technique to study the effects of cognitive and attitudinal variables upon skin resistance response to the stress of exceedingly painful and traumatic electric shock. The problem of conditioned unconscious anxiety was secondary to the main aim of his experiment. Seven of his 18 subjects were unaware, but they fell haphazardly and unevenly into his main experimental groups. Haggard utilized war words and peace words, and his subjects were shocked on the word *sword,* which was invariably preceded by the word *sharp*. Haggard, like Diven, so read his records that the response to the critical word was confused with the response to the electric shock and, so, apparently also ignored anticipatory changes. While unaware subjects reacted more than aware subjects both to the precritical word and to the critical word-plus-shock, the differences were not statistically significant. Haggard, moreover, showed that unaware subjects reacted to all words more than did aware subjects, and this general trend was significant. Therefore, the higher reaction to the precritical word *sharp* is not evidence for conditioned unconscious anxiety.

In the present study, various modifications of Diven's ingenious and promising technique are used in an attempt to demonstrate conditioned unconscious anxiety and its generalization.

Procedure

The experiment was presented to the subject as a study of mental-motor coordination. He was required to chain-associate to each stimulus word as it was presented until told to stop and, simultaneously, to tap on a telegraph key at an even rate, previously determined by the subject himself during the instruction period. These spontaneously adopted rates varied from 80 to 140 taps/min from subject to subject.

Each association-tapping interval was 15 sec. Intertrial intervals, from the end of one set of associations to the beginning of the next, were 30 sec, during which the subject sat quietly with closed eyes waiting for the next word.

The word list was as follows: plow, clock, book, corn, easy, COW, PAPER, harvest, chicken, soft, PAPER, harvest, easy, COW, gray, haystack, easy, COW, grain, copper, PAPER, harvest, blue, easy, COW, PAPER, harvest, sheep, PAPER, harvest, easy, COW, smooth, tractor, easy, COW, yellow, PAPER, harvest, farmer.

The words *cow* and *paper* are the conditioned stimuli. They are distributed haphazardly in the word list, in balanced temporal order.

The unconditioned stimulus was an electric shock lasting 5 sec, applied to a motor point in the region of the musculo-spiral nerve of the left arm, so as to produce a violent and sustained flexion at wrist and elbow, with rigid extension and adduction of the fingers. The current was automatically maintained at 13 ma (peak-to-peak of an irregular but constant wave shape) despite variations in skin resistance from subject to subject, or within a given subject during the experiment.

For members of experimental group I, the "cow-shock subjects," electric shock was delivered within 0.5 sec after the word "stop" each of the first six times they completed 15 sec of chain-association to the word *cow*. For group II, the "paper-shock subjects," shock was delivered within 0.5 sec after the word "stop" each of the first six times they completed association to the word *paper*.

It should be emphasized that all subjects were exposed to exactly the same word list. The difference between groups was only on what word they were shocked. If unconscious conditioned anxiety responses are formed, cow-shock subjects will show increasingly greater anticipatory responses to the word *cow* than to the word *paper*. Paper-shock subjects, on the other hand, are expected to show more reaction to *paper* than to *cow*. Each subject is his own control, in the sense that the responses of each subject to a critical word and a noncritical word are compared. The compared words appear equally often and in temporally balanced positions. Moreover, contamination of the conditioned anticipatory response—by physiological changes produced by the processes of association and tapping themselves—is as likely for the critical word as for the noncritical word and cannot be a biasing influence.

If semantic generalization of an unconscious conditioned anxiety response occurs, cow-shock subjects will develop greater autonomic response to rural words than to nonrural words, and paper-shock subjects will show the opposite effect.

It is to be noted that the once-repeated rural words (*plow, corn, chicken, haystack, grain, sheep, tractor, farmer*) are all nouns and all with obvious rural con-

notations. The nonrural words (*clock, book, soft, gray, copper, blue, smooth, yellow*), are nouns and adjectives and have nothing obvious in common except by exclusion from, and in contrast with, the rural words. Generalization to the nonrural words, then, implies a very different process from generalization to the rural words. The nonrural words are included in an attempt to extend our knowledge concerning the kinds of unconscious conceptualization human subjects exhibit.

The words were presented by means of a phonograph record and interroom communication system. Recording instruments, phonograph, and experimenter were all in a room separate from the subject's room, with two-way vision provided. The shocks were delivered by remote control from the experimenter's room.

The experiment was divided into four parts: (i) Shock electrodes were properly placed, and the subject was trained in performing the mental and motor tasks properly and in remaining quiet with eyes closed during the intertrial intervals. (ii) The subject was conditioned. The word list was presented once, with electric shock delivered at each presentation of the conditioned stimulus. (iii) The subject was interviewed immediately following the conditioning session. The purpose of the interview was to establish the awareness or unawareness of the subject. (iv) The conditioned response was extinguished. This session was identical with part 2, with the single exception that no shocks were ever given. During this session, however, the shock electrodes were left in place, and the subjects were not informed that they would not receive any more shocks.

Subjects. All 22 subjects were male freshmen at Antioch College, selected on the basis of personality test scores that had been administered by the College Testing Office as a part of the regular battery of placement tests administered upon admission. The personality variables are not discussed in this report.

With the cooperation of Antioch officials, a rather formidable letter was sent to all subjects "inviting" them to serve as unpaid subjects. With some difficulty, 100 percent returns were secured. We are not dealing, therefore, with the usual volunteer sample. In an experiment of this sort, results of a volunteer sample may be markedly biased.

Subjects were assigned at random to the cow-shock and paper-shock groups. Because for two paper-shock subjects there was difficulty in securing adequate blood-flow records, two extra subjects were taken, accounting for the unequal numbers in the experimental groups.

Physiological measurements. Although plantar skin resistance, digital blood flow, and heart rate were all measured, this report is concerned only with heart-rate changes.

Heart rate was recorded by the Fels cardiotachometer, using the standard electrocardiographic Lead II. This instrument records the duration of each cardiac cycle as successive R-waves reach signal level. Each cardiac period is recorded as a vertical displacement on the kymograph record. Two points need to be made concerning our treatment of heart-rate changes: (i) the sampling of heart rates, and (ii) the computation of heart-rate reaction.

Sampling. We averaged the six fastest beats to get a measure of the maximum heart-accelerating effect of the stimulating conditions of the moment. Such averages were taken for the 15-sec period just preceding each association-tapping episode and for the 15-sec period of association-tapping. Since the heart may be beating anywhere from 50 to 150 beats/min under the conditions of this experiment, we checked the adequacy of this sampling by correlating the average of the six fastest beats with the average of all the beats for one word selected randomly. This was the 16th word, *haystack*, and four correlations were computed, one each for the preassociation and the association periods in both the conditioning and extinction sessions. The number of subjects was 64, including all subjects in the entire experiment, which includes more than is being reported on here. The correlation coefficients for the four periods are .983, .984, .990, and .992. It is apparent that the sampling procedure is highly satisfactory.

Computation of heart-rate reaction. Some individuals are very underreactive in heart rate, some are overreactive. This is a consistent attribute of the individual, as previous studies of autonomic response specificity have shown (*15*). It is desirable to have a unit of measurement that will (i) reveal the processes of conditioning and generalization, no matter what the individual's reactivity, and (ii) result in equal numbers for reactions that are physiologically, although not necessarily, numerically equal. One cow-shock subject, for example, responding to the word *cow* with an increase of 20 beats/min and to the word *paper* with an increase of 10 beats/min may be showing no greater differential response than a subject who responds to *cow* and *paper* with increases of 6 and 4 beats/min, respectively. This equivalence of physiological differentiation despite nonequivalent numerical changes arises, not only because of individual differences in reactivity, but also because absolute or percentage changes are dependent upon base level.

In the present study, the correlations between base level and absolute change ranged from −.24 to −.87, with a median of −.65. Eighteen of the correlations were significant at beyond the 1-percent level, one at beyond the 5-percent level, and three were insignificant. Percentage change also correlated with base level. The range was from −.26 to −.88, with a median value of −.69. Two of the correlations were insignificant; one was significant at beyond the 5-percent level, and 19 were significant at beyond the 1-percent level. When temporal trends were eliminated by the technique of partial correlation, the correlations ranged from −.16 to −.88. The median correlation between base level and absolute change was −.73; between base level and percentage change, −.75. Four of the 44 correlations were insignificant; 33 were significant at better than the 0.1-percent level of confidence.

The two requirements—of controlling for individual differences in over-all reactivity and of base-free measure of reaction—can be met by an abstract measure of heart-rate response, the *autonomic lability score,* which we devised and tested in previous work (*15*). An adaptation of this score, the *intrasubject autonomic lability score,* is used in the present study.

The technique is illustrated in Fig. 1 which is a plot for one subject of heart rates in the 15-sec interval just before hearing a word in the word list against the heart rates during the interval of chain-association to that word. The straight line of best fit in the least-squares sense, is shown with the so-called "regression" equation $y = 0.80x + 19.8$.

This regression line is the locus of expected, or predicted, or average heart rates for this one subject, who is, incidentally, a subject of very low over-all reactivity. For example, if this subject's heart rate in the 15 sec before a word is presented were 82, we would expect—on the basis of his total performance in this situation—that he would reach a maximum heart rate during association of 85.4 beats/min [$y = (0.80 \times 82) + 19.8 = 85.4$]. For one word, at this base level of 82, the subject actually showed a heart rate of 94 beats/min (the topmost plotted point in the figure). He is obviously tremendously overreactive to this word. Since the standard error of estimate is our best estimation of the standard deviation about the line of regression, this obtained deviation from expectancy is 2.3 sigmas above expectancy ($8.6 \div 3.8$). For convenience, this value is transformed to a T-score of 73. T-scores have a mean of 50 and a standard deviation of 10. A score of 50 means that the level of heart rate during association fell on the regression line; a score of 60 means that the level during association was one

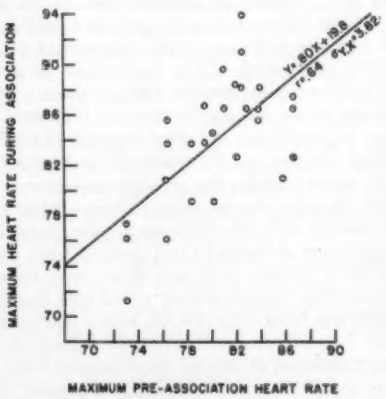

Fig. 1. Relationship for one subject between heart rate in 15-sec period before hearing a stimulus-word and heart rate in 15-sec period of association and tapping, to illustrate process of securing intrasubject autonomic lability scores. The straight line of best fit is shown, with its equation, and the standard error of estimate, $\sigma_{y.x}$, derived from the product-moment correlation r.

standard deviation higher than expectancy; of 45, one-half standard deviation below expectancy, and so on.

These deviation-from-regression-line scores are the autonomic lability scores. They are base-free. To satisfy the requirement of controlling individual differences in over-all reactivity, the scores for each individual were based upon that individual's performance; that is, regression equations were computed separately for each individual, using the individual's mean, standard deviation, and correlation.

Such scores can be used with complete accuracy, however, only when certain important statistical assumptions are met; namely, normality of distribution, linearity of regression, and equal variances in the x-arrays. In intersubject autonomic lability scoring, we have shown that these requirements are met (*15*). In the present study, however, the *N* for each scattergram was only 28 (see next paragraph). This is too small to enable appropriate tests of the assumptions. We accepted the assumptions on the basis of inspection of the scattergrams that showed no systematic deviations from the three requirements.

The scattergrams and regression equations were constructed for 28 words in the word list. These 28 words are all 16 of the once-repeated rural and nonrural words in the extinction session and the last-presented 12 of the once-repeated rural and nonrural words in the conditioning session. Omitted from the scattergrams, then, were all presentations of the often-repeated words *cow, paper, easy,* and *harvest* and of the first four words in the conditioning session. The first four words in the conditioning session were not used because reactivity to these initial words is excessive for almost all subjects. By the fifth word, subjects are adapted to the situation.

Reactions to the repeated words *cow* and *paper* were computed on the basis of this scattergram. For certain purposes, to be described later, reactions to the third and fourth words in the conditioning session were also so computed.

Methods of statistical analysis. The data are presented in the form of *response-differences,* since the design of the experiment focuses attention on the differential responses to *cow* and *paper* and to rural and nonrural words. In all cases, the response to *paper* is subtracted from the response to *cow*; and the response to nonrural words is subtracted from the response to rural words. Thus, a cow-paper response difference of +6 means that the response to *cow* was 6 T-units greater than the response to *paper*; a rural-nonrural response difference of −11 means that the response to nonrural words was 11 T-units higher than the response to rural words.

In computing such algebraic response-differences, temporal trends are controlled, since the words compared are always in the same time-segment: the response to the first presentation of *cow* is compared with the response to the first presentation of *paper,* and so on.

Because the development and extinction of the con-

ditioned and generalized responses were irregular, the technique of moving averages in blocks of three trials was adopted to smooth out these irregularities. Thus, in presenting the results for conditioning, the *first block of trials* is the average response-difference for the first, second, and third presentations of the words *cow* and *paper*; the *second block* is the average difference for the second, third, and fourth presentations; the *third block*, for the third, fourth, and fifth presentations, and so on.

The Wilcoxon nonparametric tests (*16*) were used for analysis of the results. Three different tests were applied.

1) Reliability of between-groups difference. Wilcoxon's unpaired replicates test is used, as modified by White (*17*) for the case of unequal *N*'s, to test whether cow-shock subjects differ from paper-shock subjects in the cow-paper and rural-nonrural response-differences at the beginning of conditioning, end of conditioning, and end of extinction.

2) Reliability of within-groups trends. Wilcoxon's paired replicates test is used. This is a different test of our hypotheses from the first test. The test emphasizes the uniformity with which the subjects in a given group exhibit systematic and progressive changes in their response-differences. Cow-shock subjects are expected to show increasingly larger positive response-differences as conditioning proceeds, whereas paper-shock subjects are expected to show increasingly larger negative response-differences.

3) Reliability of between-groups trend-differences. The Wilcoxon-White unpaired replicates test is again used, comparing the two groups' changes. This test asks not whether individuals uniformly develop conditioned and generalized responses but whether the two experimental groups differ in the direction and magnitude of changes they exhibit.

Results

Conditioning. Figure 2 shows the average conditioning curves for the two experimental groups. Beginning with almost identical response-differences slightly in favor of reaction to the word *cow*, the two groups exhibit a progressively increasing differential as a consequence of conditioning. By the end of conditioning (block 4) the between-groups difference is significant at between the .05 and .02 levels of confidence. The groups differ significantly only for block 4.

Despite this group difference, the development of the conditioned response within individuals is not reliable (reliability of within-groups trends) because 3 of the 10 cow-shock subjects and 4 of the 12 paper-shock subjects reverse the group trends. These atypical individuals also render the between-groups trend-differences insignificant.

The break in the procedure for the interview apparently produces a tremendous loss in a tenuously established conditioned response. The index of conditioning drops markedly from block 4 to block 5, for both experimental groups. (The fifth block includes

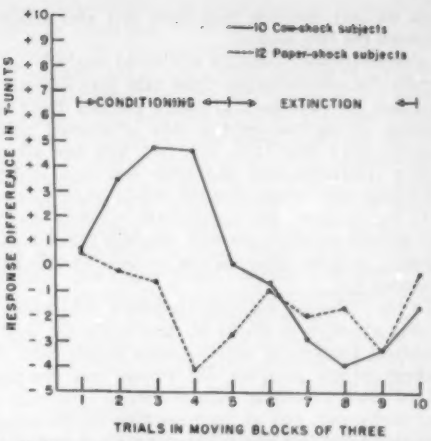

Fig. 2. Curves of conditioning for cow-shock and paper-shock subjects. A positive response-difference signifies greater heart-rate response to *cow* than to *paper*; a negative response-difference, the reverse. To smooth out temporal irregularities, trials are averaged in moving blocks of three.

the last two trials of the conditioning session and the first trial of the extinction session. The latter truly reveals a portion of the conditioned response, because the lack of reinforcement does not occur until the subject's reaction to the word and associated activity has taken place in the association-tapping interval.) This drop is significant at the .01 level (within-groups trend) for the cow-shock subjects and is not significant for the paper-shock subjects. The difference in the magnitudes and directions of this change between the groups, however, is significant at between the .01 and .001 levels.

The changes during extinction are also significant. The within-groups trend for the cow-shock subjects, comparing block 4 with block 10, is significant at the .05 level. The within-groups trend for the paper-shock subjects just misses being significant at the .05 level. Comparing the two groups (between-groups trend-differences), significance is attained at the .01 level.

In summary of these analyses: cow-shock subjects and paper-shock subjects do not differ significantly in their differential response to the words *cow* and *paper* in the first half of the conditioning session but do differ significantly in the second half of that session. The development of the conditioned response within individuals, however, is erratic, with 7 of 22 subjects showing trends in opposition to the group trends. The effects of the experimental procedures are seen much more clearly during the extinction phase of the experiment. Starting from significantly different responses in the latter half of conditioning, the two groups, under an extinction procedure, come together again. The differences in the magnitudes and directions of change in this second phase of the experiment are significant at high enough confidence levels

that we may conclude that there is a real difference between the two groups.

Generalization. Detailed statistical analysis of the results for generalization must take into account the fact that the experimental design permits direct comparison of the two groups only at selected points: namely, after zero (*18*), one, two, five, and six preceding reinforcements, and after one, two, and five preceding extinctions. For the words *grain* and *copper*, for example, the paper-shock subjects received two preceding reinforcements, whereas the cow-shock subjects received three, as can be seen by consulting the word list.

In the following analysis, therefore, data based on moving averages in blocks of three trials are used in statistical analyses of within-groups trends only. For between-groups analyses, the groups are compared (i) at zero preceding reinforcements (reaction to *book* and *corn*), (ii) at five preceding reinforcements (reaction to *smooth* and *tractor*, at the end of the conditioning session), and (iii) at five preceding extinction trials (reaction to *smooth* and *tractor* at the end of the extinction session). Reactions after six previous reinforcements, occurring at the beginning of the extinction session, are omitted because of the apparent contaminating effects of the interview. The average curves for the two experimental groups are shown in Fig. 3.

The progressively increasing differential between the two groups as a result of conditioning is apparent. The two groups do not differ significantly at zero preceding reinforcements, but the difference after five preceding reinforcements is significant at the .05 level of confidence. After five preceding extinction trials, the groups are again insignificantly different. Comparing the trends of the two groups (between-groups trend-differences), this change during conditioning is significant at below the .01 level of confidence; the change during extinction is not significant.

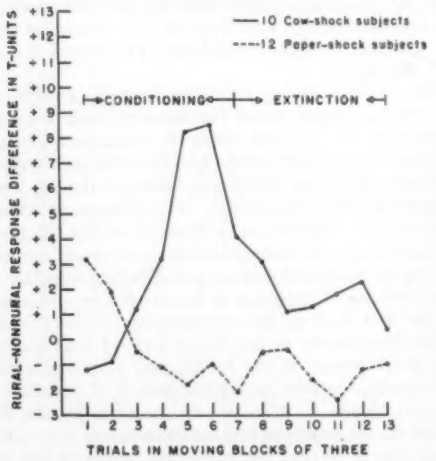

Fig. 3. Curves of generalization for cow-shock and paper-shock subjects. A positive response-difference signifies greater heart-rate response to rural words than to nonrural words; a negative response-difference, the reverse. To smooth out temporal irregularities, trials are averaged in moving blocks of three.

The within-groups trend (Fig. 3) is clear and regular for the cow-shock subjects. Each subject developed a larger positive response-difference from the first to the fifth block of trials. The confidence level is less than .01. From the first to the sixth block 9 of 10 subjects developed larger positive response-differences, with a confidence level of .01. Comparing the first and seventh blocks, the confidence level is .05. Similarly, in extinction, the trend for the cow-shock subjects is clear, the decreasing response-difference from block 5 to block 13 being significant at between the .05 to .02 levels of confidence. However, not all the results for the within-groups trend for the paper-shock subjects were significant.

In summary of the foregoing analyses, we may say that cow-shock subjects and paper-shock subjects clearly differ in the rural-nonrural response-differences they exhibit and in the progressive changes in these differences induced by the conditioning procedure. The development and extinction of the generalized response is clear-cut for the cow-shock subjects but erratic and unreliable for the paper-shock subjects.

Awareness-unawareness. After the conditioning session, each subject was carefully interviewed. The two points of the extensive interview that are relevant to this report are those concerned with the subjects' cognitions of the experimental situation.

The subjects were carefully queried concerning their expectancy of shock. The first question was invariably, "Did you know when you were going to get shocked?" This was followed by many questions designed to elicit the most fleeting and uncertain hypotheses or verbalizations concerning the administration of shock. The subjects who were "aware" instantly and correctly verbalized that shock followed *cow* or *paper*. There were only 6 out of 31 subjects in this category. These subjects, of course, have not been included in our group of 22 unaware subjects (*19*).

Other subjects were vague but could verbalize some partially correct hypothesis. "Oh, after a farm word," or "After the word *harvest*." There were only 3 of these "mixed aware" subjects, and these, too, were not included in the groups discussed in this report.

The majority of the subjects, 22 out of 31, formed no clear verbalizations, despite active attempts to anticipate the shock. Only 2 of the 22 unaware subjects reported a deliberate attempt not to think of any possible plan underlying the shock schedule; the other 20 had clearly attempted to verbalize cues. When pressed to give the hypotheses they had entertained, there were 8 reports of "after some time interval," 2 of punishment for "incorrect" or faltering associations; 2 of after a given but unknown word, 1 of "when I was

too relaxed," 1 of after a given but unknown kind of word. Seven subjects were satisfied with verbalizing only that the shock came after the word "stop." There were 14 reports in which it was clear that during the experiment the subject had been checking on the accuracy of his predictions. Five reported that they had never correctly anticipated the shock; 9 that they had been sometimes right and sometimes wrong. All these unaware subjects realized that they did not really know when the shock was coming; the hypotheses they entertained were seen by them to be incorrect.

At the end of the second, or extinction, session, they were briefly interviewed again. Twenty of the 22 subjects had nothing to add. Two developed correct but uncertain identifications of the conditioned stimulus upon requestioning but maintained that only at the time of requestioning had this hypothesis developed.

Many of these unaware subjects, although unable to verbalize the connection between the conditioned and unconditioned stimuli could verbalize some of the characteristics of the word list. Typically the subject could say, when asked, "There were an awful lot of farm words," and "Some words were repeated a lot and some were not."

Discussion and Conclusions

In this preliminary investigation, Diven's technique was modified in five particulars: (i) each subject was his own control; (ii) the physiological records were so read as to study clearly only conditioned *anticipatory* effects; (iii) the technique of physiological measurement controlled for individual differences in overall reactivity and for varying base levels; (iv) both conditioning and generalization were studied as a systematic function of the number of reinforcements; and (v) the task presented to the subjects was modified in an important fashion in that only one group of words, the rural words, cohered by virtue of common meaning. The nonrural words formed a group only by exclusion from the rural class.

Although not all the statistical comparisons reached satisfactory confidence levels, it seems clear that we may conclude that, if a word-sign becomes the signal for a painful stimulus, without the subject being able to verbalize this relationship, an anticipatory autonomic response will ensue. This unconsciously formed anxiety reaction, moreover, will appear to other word-signs meaningfully related to the conditioned word.

When one considers the arbitrary choice of words, without attention to such refinements as associative strength, word frequency in our everyday language, word length, and ease of association, the evidence for conditioned anticipatory response and its generalization bespeaks a strong and pervasive phenomenon.

The difference between cow-shock subjects and paper-shock subjects is not readily interpretable. Had both groups showed significant conditioning and generalization, the interpretation would be simple. Only cow-shock subjects, however, showed significant within-group trends for generalization. This may be because (i) generalization depends upon semantic relationships previously formed in the subject's life-experiences, (ii) generalization did occur in paper-shock subjects, but it was a more difficult task for the organism, requiring first the segregation of one group of words as being excluded from the meaning held in common by a group of rural words, and then reaction to these segregated words as a group characterized by the attribute of nonrurality. An attempt to answer these questions was made using a control group, shocked alternately on rural and nonrural words. This group did not show regular trends, as did both the cow-shock and paper-shock subjects. The individuals behaved so erratically, however, that significant differences could not be demonstrated among the two experimental groups and the control group. Rather than burden an already complicated presentation with these results, we decided to test these alternatives in another set of experiments.

There is a puzzling difference between the results for conditioning and generalization. Generalization seemed stronger, and was certainly more reliable, than conditioning. Moreover, we noted no relationship between the two. Taking these results at face value, this is the first time, to our knowledge, that a conditioned response appeared to be weaker than its concomitant generalized response or, indeed, that the two did not seem to be mutually interrelated. Previous investigations have reported only transitory equality or superiority of the generalized response over the conditioned response upon the *initial* presentation of the generalization stimuli after conditioning had been established (*20*). Our result may be (i) artifactual, as a result of our differential statistical treatment of indices of conditioning and generalization, (ii) characteristic of conditioning at the unaware end of an awareness-unawareness continuum, (iii) characteristic of anxiety responses, or (iv) a result of the combination of unawareness and anxiety. These possibilities are currently being investigated.

Our use of the terms *anticipatory autonomic response* and *unawareness* requires brief comment before this report is closed. First, what produced the heart-rate changes? We make no claim that the heart rate responded, so to speak, directly to the stimulus words. The effect may have been produced indirectly via greater muscular tension or greater expended energy in key-tapping or in association; or it may have been produced via respiratory changes; or, indeed, it may have been a compensation for a directly produced drop in blood pressure. We do not know the chain of events—physiological or behavioral or both—that produced the differential cardiac accelerations. Heart rate is used here only as an indicator.

Second, what do we mean by *unaware*? Although we carefully defined this at the outset as meaning simply that the subject could not verbally identify the conditioned signal, it should be emphasized that this "unawareness" is not a unitary indivisible phenomenon. *A priori*, several levels of unawareness might be distinguishable, ranging from nonrecognition (ver-

bal) of the conditioned stimulus even when the experimenter informs the subject what the conditioned word was, to verbal recognition of the stimulus in more or less complicated forced-choice tests. Although it is perhaps unfair to anticipate future reports, it seems appropriate to mention that this *a priori* expectation is corroborated by direct experimental evidence.

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The Scientist in Contemporary Life*

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IN a recent letter given wide publicity in the press, Albert Einstein states:

> If I would be a young man again and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find the modest degree of independence still available under present circumstances.

Einstein's letter was written in reply to a request for comment on the article "U.S. science: the troubled quest," by Theodore H. White, which was published in *The Reporter* on 14 and 23 September 1954. This is only one of many incidents that highlight the reaction of many scientists to the political and social environment in which they work.

Conversely, there are many signs of uneasiness on the part of others with respect to scientists and to scientific and technologic advance. The shadow of the A-bomb and the H-bomb hanging over the world like the sword of Damocles has intensified this growing distrust. At the recent conference on *Science and Human Responsibilities* at Washington University, E. H. Harbison of Princeton observed that "we have paid a heavy price for electric lighting, nylon, standardized radio entertainment, subways and airplanes, and the price has been a loss of spiritual values." Last year at a meeting of the American Philosophical Society, Lewis Mumford condemned physical scientists for failing to prepare society for the consequences of nuclear fission. He proposed a moratorium on science until society caught up. A few weeks ago I received a letter from the Science Council of Japan calling upon all professional societies to join in working for peace and mutual understanding by abolition of the A- and H-bombs. These are only a few examples of attitudes toward science, scientists, and the products of science which are widespread today.

It is essential for the welfare of both scientist and society that these unsatisfactory attitudes be corrected by mutual understanding and cooperation. The Cosmos Club, meeting ground of scientist, scholar, and humanist, offers them many opportunities to learn to know each other. I am taking advantage of one of these opportunities to set forth, with no claim to originality, a discussion of some of the sources of misunderstanding.

The contributions of science to mankind need no

* A talk given before the Cosmos Club, Washington, D.C., 16 Nov. 1954, and published with its permission.

defense or apology. We live in an amazing age of science and technology. We have harnessed the energy of the physical world around us, steam, electricity, chemical reaction, and some nuclear reactions; we have erected towering cities, conquered barriers of space and time by automobile, train, airplane, telephone, and radio. Through science each of us may have the equivalent of 30 slaves sweating for him without the suffering and shame of human slavery. Each of us can rent 50 million dollars' worth of telephone equipment for 10 cents. Further exploitation of the physical world will in time bring new marvels of labor-saving devices, automatic factories, rocket airplanes, space ships, and the like. The weather may be adjusted to suit our needs or whims, perhaps not tomorrow, but some day. New drugs and advances in medical knowledge will further relieve pain and suffering. All these fruits of tomorrow's science promise to lift burdens and raise the standard of living of all of us.

The contributions of science not only have included the devising of powerful tools for altering the physical environment of man but also have made major contributions to our spiritual life. Science places a high premium on intellectual honesty and on objective truth, truth that can be tested by any man in any age. Science recognizes no arbitrary authority. It does not accept the laws of gravitation because of the authority of Isaac Newton. The laws of gravitation can be observed and demonstrated as a part of anyone's experience. The ethical ideals of the scientists are high. By the efficient tool of the human intellect, he has penetrated the mysteries of the material universe and freed the minds of men from ignorance and superstition. The successes of science and their impact on every aspect of life have captured the imagination and loyalties of many men as the only guide to truth.

But science is a partial view of life, in many respects a narrow view. There is often no more naive or gullible individual than the scientist outside his own laboratory and discipline. He tends to develop a myopic vision, and to the layman his interest seems to be in details remote from what most people consider the real interests and concerns of life.

Look at an all-too-common incident of life. A child dashes to the street; there is a shriek of brakes, a cry, and a small body lying in the street. The mother comes running, moaning, wringing her hands, tears streaming from her eyes. How does science describe this event? The physicist may compute the momentum and energy of the car, the forces exerted in the collision, the shock-absorbing quality of human tissue, the strength of bones. He may measure the intensity and frequency spectrum of the various sounds or the rate of generation of tears in the eyes of the mother. The chemist may analyze the tears and reveal the exact proportion of each salt in the water which is their main constituent. He may describe in exact scientific language the fibers of the handkerchief that the mother uses to absorb the tears. The medical specialist may describe the nature of each injury and identify the one that made death inevitable. Surely each of these is an incomplete view, although accurate and true. Surely each specialist confining his activities to those of his science misses the larger aspects of the event.

The cold sharp tools of science have not been effective in penetrating the area of human emotions, purposes, and values. "It is the Nemesis of the struggle for exactitude by the men of science" remarked the biologist, H. S. Jennings, "that leads him to present a mutilated, merely fractional account of the world as a true and complete picture." "You can no more analyze these imponderables by scientific methods" said Eddington, "than you can extract the square root of a sonnet." Science advances by purposely taking a limited and incomplete view of complex events.

Science is not only a partial view of life but it is amoral. There is no moral significance inherent in high explosives, chlorine gas, or nuclear energy. Without high explosives we would not have the plentiful supply of minerals that are the foundation of our civilization. The same high explosives can be used to destroy buildings, bridges, and human beings. Chlorine gas is the basis of common bleaching agents, which make possible your white shirts. It is also a potential tool of chemical warfare. An H-bomb, releasing the explosive force of millions of tons of TNT along with searing heat and deadly gamma rays and neutrons, can destroy a whole city. Yet the potentialities of nuclear energy for benefit to mankind are as great as its potentialities for destruction. We have only begun to explore its peaceful uses. Certainly an H-bomb will not and can not fall upon us until some member of our human race loads it on an airplane and until, at the right instant, some human being pulls the bomb release handle that sends it on its way.

The knowledge obtained in the biological and medical sciences is equally amoral in character. The accomplishments of psychology and psychiatry may be applied for beneficent, selfish, or evil purposes. Modern advertising, and other propaganda, communist brain-washing—all utilize knowledge of human behavior. The knowledge of the causes of disease assists in its cure or in its spread to others. Scientific knowledge is power, but it is power to be used for good or for evil as men choose.

I think that this amoral character of science is the source of unrest of the average man with regard to the scientist and his science. What kind of men and women will control the use to which the great power of science will be put? Will they be creatures of intelligence and understanding? Will they not imagine the consequences of the waging of war with the new A- and H-weapons, and will they not in horror refrain from their use?

The memory of recent history reminds us that the misuse of the products of science for human destruction is not checked by intellectual achievement. The ability of the human mind can be perverted to evil purposes. Perhaps no nation has ever reached such

eminence in science and engineering as Germany, but this did not save her from evil leadership. The concern of laymen is with the ideals of men in authority as well as with their ideas and their intellectual accomplishments.

At the conference on *Science and Human Responsibilities* previously mentioned A. H. Compton spoke on "Man's hopes and the new need for human responsibility." He saw much hope for the future of man because man "is a being of spiritual aspiration, of human feeling and emotion." To Compton

> . . . the hope for the longer future lies in a growing understanding of the conditions for the good life of man in a world of science and technology, and the acceptance of a morality that is consistent with these conditions.

I believe that many scientists are now fully awakened to their moral and spiritual responsibilities. As was well expressed by Robert Oppenheimer, the scientist has known sin. He has seen his greatest conquest of nature applied to kiloton and megaton bombs to destroy other men. If the scientist fails to take a hand in the decisions, there are many self-confident and ambitious men who are not hampered by too much knowledge and who will not hesitate to make decisions, not on the basis of the scientist's experience or on the basis of moral values, on considerations of right and wrong, but on the basis of social and political expediency or for purely selfish reasons.

I am not one of those few who believe that we can yet abolish the use of force in the world. Its presence is an evidence of our failure, but policemen are still necessary and they must sometimes use force. As a nation we find it necessary to build great military power. I am confident that, at the present moment, such strength is a greater contribution to the peace of the world than military weakness is. Certainly those of our people who fear science most would have been the first to criticize U.S. science if the U.S.S.R. had been the first to develop A-bombs.

The scientist has come to realize that outside of his laboratory he is a man like other men, with human passions and shortcomings as well as noble aspirations and high ideals. If you have doubt of this, I suggest that you read at least some of the 992 pages of testimony in the Oppenheimer hearing. To paraphrase Shylock, as did Ley in his scientist's code of ethics: Hath not a scientist eyes? Hath not a scientist hands, organs, dimensions, senses, affections, passions? Fed with the same food, hurt with the same weapons, subject to the same diseases, healed by the same means, warmed and cooled by the same winter and summer, as other men are? If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die? And if you wrong us, shall we not revenge? If we are like you in the rest, we will resemble you in that.

Scientists, as well as others, have come to realize that atrophy of the moral and spiritual life is inconsistent with well-rounded development. Man's life at its fullest is a trinity of activity—physical, mental, and spiritual. Man must cultivate all three if he is not to be imperfectly developed. Even after thousands of years of education and religious heritage, we see far too many of our fellow-human beings living the life of animals with sole interest in the physical and sensual and exhibiting primitive minds and souls. We find a few religious fanatics who are creatures of instinct and emotion with no guidance from reason. We find many who worship reason and the intellectual life, who appear to normal men as egotistical, selfish, and soulless mechanisms. Scientists in their professional activity elevate the faculty of reason, raising it from the elemental reasoning of animals to lofty creative genius. But to cultivate reason alone and exalt it to a religion or philosophy is as monstrous as to cut off one's arm or to destroy sight and hearing. For the area of human emotions, desires, purposes, values, feelings of beauty and ugliness, love and hate, also can ascend from beastly emotionalism to lofty dreams and aspirations.

The responsibilities of scientists for the proper use of scientific knowledge for human welfare are thus the same as those of other citizens, no more, no less. Scientists and other citizens look to the wisest among us, whether scientist, humanist, statesman, or bishop, for leadership in solving the difficult problems of meeting this joint social responsibility. We demand of these leaders not only intelligence to consider and integrate the specialized knowledge of all the arts and professions but high moral and spiritual standards as well.

Let us now turn briefly to some of the factors that have produced uneasiness on the part of the scientist with regard to his government. At the risk of oversimplification I will mention the growing administrative control of the Federal Government over scientific research, the ADX battery additive case, the introduction of security-risk considerations in grants and contracts for unclassified research, and some implications of the Oppenheimer case.

No more than 20 years ago basic scientific research was conducted chiefly by independent scholars at universities and nonprofit institutions with the modest funds realized from endowments or grants from foundations. Last year the Federal Government contributed to universities and nonprofit institutions roughly three-fourths of the total funds available to these institutions for scientific research. American science has thus become largely dependent on government. Both science and government have greatly profited. Nevertheless, the government is large and science is supported by many agencies. Administrators are not all wise men, and they change frequently. As in most areas of life, he who pays the piper calls the tune. Various consequences of this elemental fact worry the scientists.

In the first place it is much easier to obtain support for applied research, which leads to the practical development of new weapons, drugs, or fertilizers, than for the search for new knowledge. Many administrators, like the ordinary layman, believe erroneously

that, with enough men and facilities, any practical goal may be reached, even when the basic scientific facts are unknown. The truth is that most practical developments rest upon a foundation of basic scientific truth, of ideas developed by men seeking to understand nature. The scientists are convinced that faster progress can be made in applied research by a more generous support of basic research. Scientists fear that basic science is not receiving adequate support and point to the relatively low appropriations for the National Science Foundation as compared with those for applied science. They fear the changeable policies as administrators change. They fear the loss of independence in the conduct of their work. The remedy for these fears is wise administration and sound national policy.

I do not have the space to pursue other aspects of this subject, such as the effect of the large government expenditures on applied research and development in enticing scientists from basic research and from the teaching profession into much more lucrative positions in industry.

The ADX battery additive case disturbs scientists. Science has frequently encountered strong differences of opinions and rivalries, but it settles them by the unquestionable test of observed experimental results. Its findings are based on objective results, with great care to remove bias and prejudice and to secure accurate results. It sees in the ADX case an appeal to politics and to expediency. It contends merely that the merits of a battery additive cannot be settled by the testimonials of laymen or by a political vote. As science, it expresses no judgment on whether the product should or should not be offered in trade.

Still another incident described by Theodore H. White in the article previously referred to is the introduction of security-risk considerations in unclassified grants and contracts. Quoting from White:

> Slowly the administrative masters of the keys have begun to regard funds for science as a favor, a privilege of the patron to give or withhold depending on a man's high-school associations, his choice of friends, the remarks of his brother-in-law.

White tells of an instance in which a grant was withheld when applied for by a certain scientist, but assurance was given that the grant would be approved if applied for in the name of his laboratory assistant.

Still another source of worry is the implication of the Oppenheimer case and, particularly, the attention and debate with respect to Oppenheimer's attitudes toward the thermonuclear bomb and continental defense. White tells of an interview with a young doctoral student who expressed his assessment of the risk of working for the government in these terms:

> It's a hell of a thought to think that you go to work for the government now and fifteen years later any politician can pull the noose around your neck just because he didn't like the clubs you joined at school.

In spite of the uneasiness felt by many scientists with respect to governmental actions and public attitudes, I am convinced that most scientists recognize the source of many of these actions and attitudes in the stresses and strains of the cold war. Most scientists do not wish they had become plumbers. Most scientists accept the necessity of secrecy and security measures in certain areas of science. They realize the necessity of advancing science faster than our enemies and are concerned about our short supply of scientists in training, our shortage of teachers of science in high school and college, our unrealistic selective service policies. They wish to break the shackles that impede our scientific progress, especially in its creative and original aspects. In this task they ask for mutual understanding and assistance of their fellow-citizens.

News and Notes

Communication of Research Results

The Communication of Research Results, a symposium sponsored by the American Institute of Biological Sciences Publications Committee, took place on 7 Sept. during the AIBS annual meetings in Florida. James Bonner (California Institute of Technology) skillfully served as chairman of a program designed to explore new ways of meeting the serious situation that has developed in the publication and assimilation of our ever-expanding research literature.

William R. Duryee (National Cancer Institute), chairman of the AIBS Publications Committee, opened the session with "A blueprint for streamlining biological journal publication." With more than 20,000 biological journals appearing regularly and the number steadily growing, even the abstracting services fail to cover more than a small fraction of the material printed. (*Biological Abstracts* includes some material from less than 2000 journals and complete coverage of only 800.)

The AIBS has established a Publications Plan that looks forward to a reorientation of research publication by 1960. This involves the following steps: 1955, gather ideas from editors and biologists for solving the problem; 1956, formulate a workable and acceptable plan; 1957, promote coordination among the various indexing and abstracting services, with the development of a single standard numbering and indexing system as a prime objective; and 1958–59, promote number coding of articles to allow for machine searching of material, and work with journals to encourage them to simplify titles, shorten papers, and voluntarily send abstracts to *Biological Abstracts*. The ob-

ject of the Publications Plan is not to impose a system but to serve as a clearinghouse for the best thinking. Any plan must be acceptable, must not interfere with dissemination of knowledge, but must result in *fewer* words. Shorter articles could be satisfactory if detailed specialized data were deposited by journal editors in regional libraries coordinated by the Library of Congress; these data would then be available by photoreproduction at the user's expense.

Richard M. Hewitt (Mayo Clinic and the Mayo Foundation of the University of Minnesota), speaking humorously and tellingly on "Better preparation of material," opened his talk with the observation that our research reporting system encourages repetition, orally and in writing, in text, abstract, and review of research results. Thus, a few ideas are buried in a mountain of words. For oral reporting, Hewitt deplored the presentation of illegible slides.

The written reporting of research is part of the research; it is necessary to be as accurate at the desk as at the laboratory bench; each illustration should serve a purpose; duplication of information in text, tables, and graphs is unjustifiable; and too many references are—too many. An experienced author also knows that he should not release what he has written when angry, elated, or depressed, and elation is the most dangerous of these emotions.

A wise author works from an outline, detailed and carefully prepared. A great deal more time should be spent in the preparation of the outline than on composition. Consistency in the handling of the material and in the use of terms is equally important. One trick of the trade that saves words is the substitution of verbs for stock substantive expressions: not "*Retention* of water occurred in the starved rats," but "The starved rats retained water." And finally, the speaker outlined with graphic examples an array of pitfalls in writing—pronouns used without antecedents, new verbs made from nouns, colloquialisms, nouns used as adjectives, and the incorrect use of words, more often common English words than technical terms.

Robert Bray (Library of Congress), in discussing "Modern reproduction of material," emphasized the flexible use of both new and old methods of reproduction to serve specific needs. Microcards in 3- by 5-in. size are convenient for filing but cannot be enlarged economically, whereas sheet film can be enlarged when needed. The Diazo Process, incorporated in many commercial copying devices used in business firms, provides a method for making single reproductions from single sheets of paper without the use of a lens. The most promising of the new devices is Zerography, because reproduction is achieved electrically, eliminating the disadvantages of chemical processes, and the resulting copy compares favorably in quality with that produced by standard photographic techniques.

The speaker described the experiment in facsimile reproduction, sponsored by AIBS, that is now in operation between the Library of Congress and the National Institutes of Health. Pages of material are transmitted by wire through the use of an electronic scanner; the copy is fairly clear and is usable for most purposes.

The publication system of the American Society of Civil Engineers was described. The society's journal merely lists the titles of technical papers, each with a number, and members order by number, as separates, only the articles of interest to them. The PB report system, operated by the Library of Congress in cooperation with the Office of Technical Services of the Department of Commerce, was also described. In this system the office deposits single copies of reports with the Library of Congress, whose Photoduplication Service sells microfilms or photostats on request. Customers of this service are largely in industry or small business, and the reports are usually technical in nature.

Ralph Shaw (Rutgers University), former librarian of the U.S. Department of Agriculture, discussed "Indexing and rapid differential selecting of material." He emphasized that machines will not replace printed bibliographies and card catalogs or those who make them; however, machines, by saving time and money in searching for material, can release time and funds to achieve a better organization of our knowledge.

Reviewing various kinds of electronic devices, such as digital computers, Shaw pointed out their disadvantages for bibliographic work, disadvantages stemming from the fact that they were not designed for this purpose. The Rapid Selector is at present the only one engineered for bibliographic use; it combines the flexibility of binary electronic searching with high-speed photographic reproduction. By combining a punched-card code and a photocell synchronized with an auxiliary camera, it provides an enlarged print of the data from standard 35-mm film. This corresponds to whatever code number the user wishes to find. Thus, hundreds of thousands of items can be scanned to select all the items desired in a matter of minutes. Not only can greater quantities of material be sifted, but they can be sifted with greater accuracy and without hand-copying.

The success of the Selector does not depend upon agreement on a uniform scheme of classification or listing of the material in all conventional systems of indexing. A system of random numbering permits use of code numbers for the known concepts as they are currently organized in any field, and as new concepts develop additional code numbers can be assigned consecutively with a numbering stamp. Synonyms are given the same code number, and new concepts can be added without fitting them into a numbering sequence. By the use of separate code books and films, the same numbers can be used for different sets of abstracts or for journals in various languages. Some fundamental thinking about the organization of information is needed before full advantage can be taken of this new tool.

Ralph Cleland (Indiana University) presented a most provocative proposal in his paper on "The use of material." He pointed out that the publication of

research papers was designed to serve two purposes, namely, to inform a relatively few individuals of the details of a given research project, and to give a larger audience a summary of the reasonings and findings. This is economically unsound, since a circulation of 2000 to 3000 for an article read in toto by no more than 20 to 100 people may be costing the sponsoring society or group about $10 per reader. To eliminate this expensive procedure and to obviate the necessity of exchanging reprints, it was suggested that a journal might publish a condensed version of a scientific paper and make the complete documented text available to the few who want it in some less expensive form.

Three possible ways of effecting this were proposed. The American Documentation Institute and University Microfilms, Inc. (the latter restricted at present to Ph.D. dissertations), could expand their services to supply microfilm editions of full-length papers if more journals would use their services and adopt the plan of printing only short articles. This might lead to many papers appearing only in the short form, since authors might often find they could say all that was necessary in the condensed version, thus fostering the art of brevity. The third possibility would be to accomplish the same purpose through the use of microcards, a more convenient form in the speaker's opinion. Researchers would buy only what they needed, and by the elimination of exchange of reprints, both money and storage space would be saved. The publication of shorter articles would result in reduced subscription rates. This reduction would enable libraries to have complete sets of microfilms or microcards available to aid a purchaser to decide whether or not he needed a given full text.

A more radical departure would be to combine a large number of journals into a departmentalized newspaper, the editorial selection to be retained by professional groups but the copy editing and publishing to be done by production experts. This paper could be a weekly containing short scientific articles (detailed data supplied as outlined in the preceding paragraph), editorials, symposiums, news items, letters and discussion, book reviews, and advertising. One daily issue of the *New York Times*, selected at random, contained 135,834 words of news material, about twice the number of words published in the *American Journal of Botany* in an entire year. By using rotary presses and newspaper techniques, greater speed and economy would be effected. The economy factor would be enhanced by the attractiveness of the paper for advertisers. Subscription rates could be low, and a reduction in society dues would be possible.

Based on actual figures for a typical newspaper with a circulation of 50,000, the speaker calculated that a paper, combining the contents of 10 journals and having a circulation of 15,000, would cost the subscriber only $3 to $5 per year. This would be no more than a tenth of the present cost for the same amount of journal material. (An article based on Cleland's paper will appear in a forthcoming issue of *Science*.)

The large attendance at the symposium and the lively discussion offered strong evidence of the interest in the critical problem of research publication.

JOHN A. BEHNKE *for*
Publications Committee of the AIBS
American Association for the Advancement of Science, Washington 5, D.C.

Science News

The American Society of Plant Physiologists passed this resolution during its annual meeting in Gainsville, Fla., in September.

> It has come to the attention of the American Society of Plant Physiologists that political criteria are now being employed by the Department of Health, Education and Welfare in the awarding of research grants through the U.S. Public Health Service. We deplore this practice for we feel the introduction of such political considerations into scientific effort to be contrary to American tradition and to be harmful to science as a whole. We respectfully urge a return to former selection procedures, in which only the scientific merit of the research proposal and the integrity and research record of the investigator are judged.

To implement its program of attack on trachoma and certain other eye diseases, the Arabian American Oil Co. has begun a joint 5-yr, $500,000 research program with Harvard University. The research group will be headed by John C. Snyder, dean of the School of Public Health and head of the department of microbiology, assisted by Edward S. Murray and Shih-man Chang, specialists in virus diseases. Arabian American will make available the facilities of its new medical center in Dhahran, Saudi Arabia, including three modern laboratories. Harvard will provide the professional and technical staff for the scientific work.

The United States did not take part officially in the 4th **World Forestry Conference** that opened at Dehra Dun, India, on 11 Dec. Tom Gill of Washington, D.C., delegate from the Society of American Foresters, said the State Department decided against official participation because the Chinese Communists were sending a delegation.

The results of preliminary spectrographic investigation of 24 samples of ash taken from Kansas coal showed that the **germanium content** ranged from 0.0036 to 0.0680 percent in the ash and from 0.00069 to 0.00480 percent in the total coal. Using the price of germanium at $295 per pound, as it was in February of this year, John A. Schleicher and William W. Hambleton of the University of Kansas determined that the germanium content of the Kansas coal was worth from $4.06 to $28.40 per ton of coal. One sample, which contained 21.8 oz of germanium per ton of ash, was valued at $401.20 per ton of ash, if no germanium were lost in the processing. This compared

favorably with both present domestic and foreign prices of the metal.

The chief source of domestic germanium has been the residues derived from the smelting of zinc ores. In Germany, England, and Japan, there are several plants already in operation that recover the metal from the fly-ash and residual ash of coal. In this country there has been some questions about the practicability of obtaining germanium from coal because the thick veins of eastern coal show low concentrations of the metal. However, Kansas coal seams are much thinner and this might be a factor in the high concentration found in the study. The U.S. Geological Survey is planning to conduct further investigations of the germanium in Kansas coal next spring.

A record ratio of **1 doctor for every 730** persons in the United States has been reached during 1953–54 through the graduation of 6861 physicians, the largest group in history.

At a special conference held in New York on 9 Dec. the legislative committee of the **American League Against Epilepsy** discussed and recommended reform of outmoded state laws requiring sterilization of epileptics, prohibiting their marriage, limiting their employment opportunities, and forbidding them to operate motor vehicles. The committee indicated that these laws had long caused profound economic deprivation and moral despair among hundreds of thousands of citizens who, with their seizures partially or wholly controlled, were for all practical purposes normal human beings.

The four major recommendations for changes in state legislation were made in the light of a 2-yr study conducted by Roscoe L. Barrow, dean of the College of Law of the University of Cincinnati. Barrow's study was supported by a grant from the National Institute of Neurological Diseases and Blindness. These recommendations may be summed up as follow: (1) eugenic sterilization laws should be amended to render them inapplicable to epileptics; (2) eugenic marriage laws should be amended to render them inapplicable to epileptics; (3) motor vehicle licenses should be considered for those epileptics whose seizures have been completely controlled for a period of 2 yr; (4) workmen's compensation laws should be amended so that employers are protected from liabilities resulting from injuries to or by epileptics caused by epileptic conditions.

Some 25 young **West German scientists** are to come to the United States at the invitation of the Government to study for 2 yr in American institutions. The program is aimed at strengthening German science and its industrial application. Atomic energy will be one of the chief fields of study, for the U.S. has agreed to help Germany in developing atomic energy for peacetime use. This country also is shipping a considerable quantity of nuclear research equipment to Germany.

In an article in the December issue of *Harper's Magazine*, Leonard Engel medical writer, says that many cancer investigators find serious flaws in the statistical evidence linking **cigarettes and lung cancer**. He reports that William C. Heuper, chief of environmental cancer research at the National Cancer Institute, has pointed out that the lung cancer mortality rates in various countries should parallel the national consumption of cigarettes. However, in Central Europe the rise in lung cancer began before the turn of the century and not in 1920 when cigarette smoking became widespread.

A British scientist, Sidney Russ, states that Denmark, Switzerland, and the United States have nearly identical death rates from lung cancer, but the Swiss and Danes smoke only half as many cigarettes per capita as we do. Again, cigarette consumption in England and Wales is 30 percent below the level of the U.S.; but lung cancer mortality in these areas is almost two and a half times as great.

Engel writes that the "most puzzling inconsistencies" are to be found in the proportions of men and women dying of lung cancers. As a whole, cancer of the lung is a masculine disease, theoretically because men have been smoking longer and in larger numbers than women. Curiously, however, the disproportion is growing in the U.S. and several other countries —though a larger proportion of women now smoke.

On 27 Nov. the **first experimental reactor** to be built in Sweden was officially shown to an assembly of scientists, industrialists, and other notables headed by King Gustaf Adolf and two cabinet ministers. The reactor's present 10-kw capacity will soon be increased to 300 kw, and plans have been formulated for the construction of a 20,000-kw reactor within 3 to 4 yr.

Foot-and-mouth disease, a virus that infects cattle, has been transmitted by inoculation to young chicks in the laboratory. Heretofore, it had been believed that both domestic and wild fowl are resistant to the disease. H. H. Skinner of the Research Institute (Animal Virus Disease), Pirbright, Surrey, England, reported in the 4 Dec. issue of *Nature* that he inoculated young chicks intramuscularly and chick embryos intravenously with strains of the disease taken from cattle, mice, and guinea pigs. He recovered the virus from the blood and observed characteristic lesions of the tongue in both newly hatched chicks and birds 2 to 4 mo old.

In chickens of all ages there was no severe systemic disturbance in the course of the infection. The affected tongue tissue usually was flaked off in 1 or 2 days and the tongue left without a blemish. Both the cardiac and skeletal muscles of the chicks inoculated in the embryo stage were observed to show signs of the infection, as is the case in the infection of the young of many other species.

Skinner also reported a successful attempt to infect chick embryos 7 to 10 days old with the virus of vesicular stomatitis, a disease with symptoms similar to

those of foot-and-mouth disease. "... adult and young birds were highly susceptible to infection with the virus of vesicular stomatitis when this was inoculated intradermally into the tongue."

The government expects soon to introduce a new game bird into the United States. It is the black francolin (*Francolinus francolinus*), a beautiful, nonmigratory bird from Pakistan that will probably be "planted" in the southwest. Gardiner Bump, Fish and Wildlife Service biologist in charge of **foreign bird introductions**, is now in Karachi. He hopes to send back a few hundred black francolins, several times the minimum number necessary to make a successful plant.

The black francolin is closely related to the 194 gray or brown francolins introduced into Arizona from Pakistan last year. A Federal-State program, financed by excise taxes on sporting arms and ammunition, seeks to restock game birds in the United States, mostly in the dry southwestern portion where there are now few upland game birds. Under the program the Government has brought in more than 3700 chukor partridges from Turkey in the last 3 yr. Stemming from the same family as the bobwhite, the chukors were sent mainly to Arizona, New Mexico, and Utah.

Other game birds finding new homes in the United States in the last 3 yr include nearly 270 Spanish red leg partridges for southeast Colorado, which the Government hopes will soon be increased by 600 newcomers; 40 seesee partridges from Pakistan and Turkey for New Mexico, with more expected to follow; 55 Hungarian partridges from Turkey, of a race adaptable to southwestern conditions; 5 sand grouse from Turkey for Arizona; and 3 Turkish pheasants, owned by the State of Missouri and now on a Tennessee game farm. The most famous game bird transplanted into the United States is the pheasant, successfully imported from China in 1880.

Scientists in the News

Paul E. Klopsteg has resigned as associate director of the National Science Foundation, effective 31 Dec., to return to his home in Glenview, Ill., where he is establishing an office for consulting activities in research and education in science and engineering. He will continue as a member of the Personnel Security Review Board of the Atomic Energy Commission, and will serve as special consultant to the National Science Foundation and to the dean of the Technological Institute at Northwestern University [See *Science* **120**, 592 (15 Oct. 1954)].

At its 35th annual meeting the Swedish Academy of Engineering Sciences awarded gold medals to the following scientists: **Erik Stemme**, for directing the team that in 3 yr built the binary electronic computing machine, BESK; **Gunnar Jancke**, for his role as leading engineer in the design and development of Sweden's new network of 380,000-v transmission lines between the Lapland waterfalls and the central and southern parts of the country; **Erik Bergstrand**, for designing the geodimeter, an instrument for measuring geographic distances by determining the distance traveled by light reflexes; **Olle Wernholm**, for his work in perfecting electron accelerators. **John Chipman** of Massachusetts Institute of Technology, the first non-Swede to be so honored, received the Academy's Brinell medal for his important achievements in metallurgy and metallography.

A. Nelson Dingle has joined the staff of the University of Michigan, where he will be associated with E. Wendell Hewson and others in establishing a program of applied meteorology. The group is undertaking to develop the interdisciplinary phases of meteorology in such fields as medicine, public health, engineering, and biology. A teaching and research laboratory is being built by the university to provide a center for these studies.

Arthur G. Milnes, a specialist in magnetic amplifiers and principal scientific officer of the British Ministry of Supply, has joined the faculty of Carnegie Institute of Technology as visiting associate professor of electrical engineering. His 1-yr leave from the Royal Aircraft Establishment at Farnborough is supported by an FOA fellowship granted by the Royal Society of London in conjunction with the National Academy of Science in Washington. He will work with L. A. Finzi, who is also an authority on magnetic amplifiers.

Harold A. Wilson, professor emeritus of physics and former head of the department at Rice Institute, was honored by colleagues and friends at a formal dinner on his 80th birthday. Wilson was one of the original members of the Rice faculty. He is a fellow of the Royal Society of London and of the American Philosophical Society, as well as a member of the Cambridge Philosophical Society, the London Physical Society, and the American Physical Society. Annually former students of Rice contribute to the H. A. Wilson memorial award given to the graduate student doing the best research in physics.

The Society of American Foresters presented two of the forestry profession's highest awards during the society's meeting in Milwaukee, Wis. **William L. Hall** of Hot Springs, Ark., received the Gifford Pinchot medal. Hall was a cofounder with Mr. Pinchot of the society, and is the owner and manager of extensive timberlands in Arkansas. At the age of 81, he is the oldest professional forester in America in active practice.

Tom Gill, executive director of the Charles Lathrop Pack Forestry Foundation, Washington, D.C., was presented the Sir William Schlich memorial medal. Schlich (1840–1925) was inspector general of forests

in India, professor of forestry at Oxford University, and author of the *Manual of Forestry*, an early work on forest management. Gill was honored for distinguished service to international forestry. He has been a forestry consultant to several governments in Central America and the Orient, and is a special forestry adviser to the Food and Agriculture Organization of the United Nations.

Wallace E. Pratt, of Carlsbad, N.M., former vice president and director of the Standard Oil Co. (New Jersey), is the 1954 recipient of the American Petroleum Institute's Gold Medal award for distinguished achievement.

Hans Schwerdtfeger, mathematician of the University of Melbourne, Australia, is spending a year as a visiting professor at Queen's University, Kingston, Ontario, Canada. He is completing a book on the geometry of complex numbers, in collaboration with Peter Scherk of the University of Saskatchewan. Schwerdtfeger is planning to visit New York University in January and several other American institutions at later dates.

A. E. Pierce, a principal scientific officer of the Agricultural Research Council of Great Britain, stationed at the Institute of Animal Physiology, Cambridge, is utilizing a 1-yr fellowship in veterinary protozoology at the McMaster Animal Health Laboratory in Sydney, Australia. One of his particular fields of interests has been bovine trichomoniasis and he spent 2 yr as Wellcome research fellow at the University of Wisconsin studying the chemotherapy of this disease.

Vesto M. Slipher has become director emeritus of the Lowell Observatory, Flagstaff, Ariz., after 53 yr of continuous service, the last 38 of them as director. His outstanding work in astronomical spectroscopy, including his discovery of the red-shift in the spectrums of extragalactic nebulas, led to his receiving the gold medal of the Royal Astronomical Society, the Bruce medal of the Astronomical Society of the Pacific, and many other honors. He plans to continue his planetary and nebular studies.

Slipher is succeeded by **Albert G. Wilson**, who has been assistant director since 1953. Wilson was previously on the staff of the Mount Wilson and Palomar Observatories and a member of the faculty of California Institute of Technology. During 1949–53 he was astronomer in charge of the National Geographic Society–Palomar Observatory Sky Survey.

Donald H. Hale, colonel, has been named deputy commanding officer of the Chemical Corps Research and Engineering Command, Army Chemical Center, Md. He succeeds **Alexander Grendon**, colonel, who retired last month. Hale will assist the commanding general of the Research and Engineering Command, John R. Burns, in the direction and control of the Chemical and Radiological Laboratories, Medical Laboratories, and Engineering Agency, all at the Chemical Center, as well as Dugway Proving Ground, Utah, and the Chemical Corps installation at Muscle Shoals, Ala.

Ralph D. Bennett, senior scientist and technical director at the U.S. Naval Ordnance Laboratory, Silver Spring, Md., resigned on 1 Dec. after 14 yr of service to accept a position as manager of the technical department of the Knolls Atomic Power Laboratory, Schenectady, N.Y., research facility managed by the General Electric Co.

L. L. Thurstone, research professor of psychology and director of the Psychometric Laboratory of the University of North Carolina, recently returned from Sweden, where he was awarded an honorary doctorate by the University of Gothenburg. Last spring he was visiting professor of psychology at the University of Stockholm.

Howard A. Eder, an investigator in the metabolism laboratory of the National Heart Institute, has been appointed associate professor of medicine of the State University of New York College of Medicine, Brooklyn, effective early in 1955.

Necrology

Ernest B. Babcock, 77, pioneer in experimental taxonomy and professor emeritus of genetics at the University of California, Berkeley, 8 Dec.; **Charles F. Daniels**, 39, thoracic surgeon and codesigner of the Chamberlain-Daniels vacuum pump, New York, 8 Dec.; **John Eiman**, 67, pathologist and director of laboratories at Abbington Memorial Hospital, Philadelphia, 3 Dec.; **Charles W. Elmer**, 82, astronomer, lecturer, and founder of the Custer Institute for Scientific Research, Greenport, N.Y., 7 Dec.; **Vladimir V. Golubev**, 70, mathematician, authority on aerodynamics, and author, Moscow, 5 Dec.; **Harry C. Gossard**, 70, mathematician and former dean of Eastern New Mexico University, Portales, N.M., 6 Dec.; **Edmund J. Longyear**, 90, mining explorer, Los Angeles, 4 Dec.; **Edmund B. Montgomery**, oldest practicing physician in the United States and yellow fever expert, Quincy, Ill., 8 Dec.; **Charles Palache**, 84, crystallography expert, former president of the Geological Society of America, and professor emeritus of mineralogy at Harvard University, Cambridge, Mass., 5 Dec.; **Stephen B. L. Penrose, Jr.**, 46, former professor of physics, author, and president of the American University of Beirut and International College, Beirut, Lebanon, 9 Dec.; **Frank J. Remy**, former instructor of oral hygiene at Columbia University, New York, 6 Dec.; **Florence Robertson**, 45, professor of geophysics and geophysical engineering in the Institute of Technology of St. Louis University, St. Louis, 18 Nov.; **Julius V. Sommer**, 66, former analytical chemist for the Esso Research Laboratories, Linden, N.J., 6 Dec.

Meetings

International medical authorities visited the University of Pennsylvania 8–9 Dec. to attend a series of conferences for consideration of the muscular disorder known as myasthenia gravis. The meeting was held under auspices of the **Myasthenia Gravis Foundation,** New York. George D. Gammon, professor of clinical neurology at the University of Pennsylvania School of Medicine and vice chairman of the foundation, arranged the program. Among the foreign visitors was Andrew Wilson of the University of Liverpool, England, who spoke on the action of extracts of the thymus on myasthenia gravis; H. D. Churchill-Davidson of St. Thomas Hospital, London, who described neuromuscular transmission in myasthenia gravis; and Eleanor Venning of McGill University who discussed endocrine changes in normal pregnancy.

The School of Agriculture of Michigan State College is sponsoring a centennial symposium, **Nutrition of Plants, Animals, and Man,** 14–16 Feb. 1955. The program is designed to interest people professionally concerned with nutrition rather than the general public, to review current experiments, and to assess present knowledge concerning the influence of soil fertility on the nutritive value of animal and human food. It is hoped that the inclusion of speakers with national and international reputations will add to the interest of the meeting.

The program the first day will be devoted largely to a consideration of the chemical composition and nutritional quality of plants. L. A. Maynard, A. G. Norman, and K. C. Beeson will be the principal off-campus speakers. The second day will be devoted to animal and human nutrition with these specialists participating: W. A. Albrecht, E. N. Todhunter, W. J. Darby, and L. E. Clifcorn. On the third day, H. D. Anderson, A. B. Keys, O. V. Wells, and Alice Smith will consider the public health aspects of the problem and, with other speakers, will conduct a panel discussion on all phases of the symposium.

Each day members of the Michigan State College staff will contribute their findings. In addition to the above specialists, other experts will be invited to participate. Attendance will be limited in order that discussion may be as free as possible. For information write Continuing Education Service, Kellogg Center, Michigan State College, East Lansing. The proceedings of the symposium will be published.

The 5th conference of the **Chemical Engineering Division, Chemical Institute of Canada,** will be held 7–9 Mar. 1955 in Ottawa. Under the chairmanship of Paul E. Gishler, 2 days will be devoted to technical papers—including a half-day on atomic energy developments, a half-day on the fundamentals of drying, and a half-day on general chemical engineering topics.

One of the features of the meeting will be a trip to the Chalk River Plant of Atomic Energy of Canada Ltd. by a limited number of participants who must have security clearance. Inquiries regarding the trip should be mailed to Dr. W. M. Campbell, Box 323, Deep River, Ont.

The spring meeting of the **Committee for the Scientific Study of Religion** is to be held in New York 16 Apr. 1955. The general theme is *Psychiatry and Religion.* Social scientists with research to report in the general area of religion should send three copies of 300-word abstracts of 15-min papers to the secretary, Walter Houston Clark, Hartford Seminary Foundation, Hartford 5, Conn., *before 1 Mar.*

Society Elections

Indiana Academy of Science: pres., A. H. Meyer, Valparaiso University; v. pres., Willis H. Johnson, Wabash College; chair. of program committee, John Mizelle, University of Notre Dame; sec., W. A. Daily, Eli Lilly and Co., Indianapolis; treas., Frank J. Welcher, Indiana University.

Academy of Psychosomatic Medicine: pres., William Kaufman, Bridgeport, Conn.; v. pres., Bernard B. Raginsky, Montreal, Canada; sec., Ethan A. Brown, Boston, Mass.; treas., Alfred J. Cantor, Flushing, N.Y.

Instrument Society of America: pres., Warren H. Brand, Conoflow Corp., Philadelphia; treas., Justus T. Vollbrecht, Energy Control Co. The vice presidents are A. A. Anderson, Swissomatic Products, and W. H. Fortney, Humble Oil and Refining Co.

American Society of Ichthyologists and Herpetologists: pres., Edward C. Raney, Cornell University; sec., Arnold B. Grobman, Florida State Museum; treas., Coleman J. Goin, University of Florida; publications sec., N. Bayard Green, Marshall College. The vice presidents are Robert C. Stebbins, University of California; L. M. Klauber, San Diego, Cal.; and Ernest A. Lachner, U.S. National Museum.

The American Orthopsychiatric Association, Inc.: pres., Simon H. Tulchin, New York; v. pres., Elizabeth H. Holmes, Boston, Mass.; sec., Jessie Edna Crampton, Brooklyn, N.Y.; treas., William S. Langford, New York; past pres., Hyman S. Lippman, St. Paul, Minn.; pres.-elect, Exie E. Welsch, New York; editor of journal, George E. Gardner, Boston Mass.

Mycological Society of America: pres., William W. Diehl, Bureau of Plant Industry, Beltsville, Md.; pres.-elect, Ralph Emerson, University of California, Berkeley; v. pres., Josiah L. Lowe, Syracuse University; sec.-treas., E. S. Beneke, Michigan State College.

American College of Dentists: pres., James H. Ferguson, Baltimore, Md.; v. pres., C. V. Rault, Washington, D.C.; pres.-elect, Kenneth C. Pruden, Paterson, N.J.; treas., William N. Hodgkin, Warrenton, Va.; sec., Otto W. Brandhorst, St. Louis, Mo.

Education

With the financial support of the National Science Foundation, a **visiting lectureship program** is being administered by the Mathematical Association of America during 1954–55. The object of this program is to assist teachers in colleges and universities in introducing modern ideas into undergraduate mathematics and in improving the quality and increasing the quantity of their mathematics students—not only those students who will become research mathematicians but those who will apply the subject in other fields, teach it in secondary schools and colleges, or become part of the generally informed public.

With this end in view, the lecturers are prepared not only to give formal lectures but to confer with students and faculty singly and in groups. They will be glad to advise students on future opportunities in study and employment, to discuss teaching problems and curriculum with members of the staff, and to throw what light they can on practices in comparable institutions.

There will be five lecturers: R. H. Bing, University of Wisconsin; W. L. Duren, Tulane University; Tomlinson Fort, University of South Carolina; George Polya, Stanford University (emeritus); D. V. Widder, Harvard University. Polya will tour the area roughly west of the Mississippi River for 3 mo. The other lecturers will for the most part remain east of the Mississippi. Widder will be available from 27 Mar. to 1 May; Bing for parts of the fall semester; Fort in February 1955; Duren in the fall semester. A detailed itinerary is to be found in the December (1954) issue of the *American Mathematical Monthly*.

Dedication ceremonies were held recently for the new $723,480 Barnard Free Skin and Cancer Hospital, located in the **Washington University-Barnes Hospital Medical Center**, St. Louis. The new building has five floors and a 42-bed capacity. The fifth floor will house a tumor clinic operated by the Washington University Clinics. This clinic recently received gifts totaling $130,000 for construction and equipment. Of this amount, $50,000 was received from the Donald L. Barnes Foundation and Mr. Barnes personally for equipment, approximately $60,000 came from an anonymous donor, and about $15,000 to be used for construction was received from the university's department of radiology. The project to build the fifth floor was initiated by an additional pledge of $10,000 by Wendell G. Scott, associate professor of clinical radiology and his associates in that department, and also by some of their patients who are interested in increasing the opportunities for research in the field of cancer and malignant tumors.

A 24-million volt betatron, purchased and operated by the Mallinckrodt Institute of Radiology, is on the ground floor of the building. The Mallinckrodt Institute also will provide radiological services for the hospital. Research laboratory space has been provided on the second floor, and patients will be housed on the third and fourth floors.

Available Fellowships and Awards

The **International Academy of Proctology** has announced its 1954–55 contest for the best unpublished contribution on proctology or allied subjects. The winner will receive $100 and a certificate; certificates will also be awarded to other especially deserving entries. This competition is open to all physicians in all countries, whether or not affiliated with the academy. The formal presentation of the first prize and of the certificates will be made at the annual convention of the academy on 26 Mar. 1955 at the Plaza Hotel in New York.

The academy reserves the exclusive right to publish all contributions in the *American Journal of Proctology*. All entries are limited to 5000 words, must be typewritten in English, and submitted in quintuplicate. *Entries must be received no later than 1 Feb. 1955.* They should be addressed to the International Academy of Proctology, 147–41 Sanford Ave., Flushing 55, N.Y.

Candidates for the $2500 **Merck graduate fellowship in analytical chemistry** are now being sought for 1955. The fellowship is sponsored each year by Merck and Co., Inc., Rahway, N.J., and administered by the American Chemical Society. The applicant believed capable of contributing most to the advancement of the theory and practice of analytical chemistry during his course of study and in the future will be awarded the fellowship, contingent upon the candidate's acceptance by the institution and professor selected for the proposed study program. An outline of the proposed academic program and the name of the professor must accompany the application.

The institution selected must be one whose undergraduate instruction in chemistry is approved by the American Chemical Society. In Canada, the institution must also be approved by the Chemical Institute of Canada. A student will be eligible to have the fellowship renewed twice, but no student may hold it for more than 3 yr.

Application blanks may be obtained from the American Chemical Society, 1155 16th St. NW, Washington 6, D.C. They should be completed and returned to the Merck Fellowship Committee, at the same address, along with letters of recommendation and transcripts of credits. *Deadline date for receipt of all material is 1 Feb. 1955.*

Applications for **Atomic Energy Commission fellowships** for 1955–56 in radiological physics and in industrial hygiene are now being received by the Oak Ridge Institute of Nuclear Studies. The two fellowship programs have taken on increased importance in view of increased industrial participation in the atomic energy program and the impending development of power reactors for the generation of electricity and for propulsion purposes.

The industrial hygiene fellowship program supports individuals who are studying for the master's degree in this field at either the Harvard University

School of Public Health or the University of Pittsburgh Graduate School of Public Health.

Radiological physics fellowships are carried out in three separate programs as follows: At Vanderbilt University and Oak Ridge National Laboratory, at the University of Rochester and Brookhaven National Laboratory, and at the University of Washington and the Hanford Works. In each case 9 mo of course work at the university is followed by 3 mo of additional study and field training at the cooperating AEC installation. Up to 25 fellows may be appointed in each of the three programs, and course work may be applied toward an advanced degree. Six-month extensions may be granted in some cases for completion of work on the master's degree.

Basic stipend for both fellowships is $1600, with an allowance of $350 for a spouse and $350 for each dependent child. Tuition and laboratory fees are paid as a part of the fellowship. Industrial hygiene fellows may receive an additional allowance of $200 if they have already completed a year of graduate study or have appropriate work experience. Application forms and additional information may be obtained from the Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

Miscellaneous

The **National Society of Professional Engineers** expects to occupy new headquarters on K St. NW, Washington, D.C., by the early fall of 1955. The basement and first two floors will be occupied by the society, and the top two floors will be rented as office and meeting-room space. The building will also house the offices of the *American Engineer*, monthly periodical published by the society.

Any teacher or industrial chemist interested in directing a new project in the **National Cooperative Undergraduate Chemical Program** (NaCUR) should write to Mrs. Ethaline Cortelyou, Armour Research Foundation, Chicago 16, Ill., *before 20 Jan. 1955*, if the project is to be listed for the 1955–56 college term in the annual article that appears in the May or June 1955 issue of the *Journal of Chemical Education*. For the 1954–55 college year NaCUR offered 20 projects for student participation—7 of them analytic; 12, organic; and 1 biochemical.

The NaCUR program was organized at the St. Louis meeting of the American Chemical Society in 1948 to stimulate undergraduate research and to supply chemical data. The major premise of the program is that usable chemical information can be obtained from duplicating work done by two or more undergraduate students in different colleges, independent of and unknown to one another.

Early in the 6 yr of its active existence, it became obvious that an additional purpose served by the program is to stimulate or revive research interest in teachers of small colleges who previously have felt handicapped by limited funds, facilities, time, and research quality students. A fourth aim, recently added, is to give industry an opportunity to participate in the stimulation of undergraduate chemical research to help insure for itself a continuing supply of young chemists and chemical engineers.

The program is set up under a system of research projects that are simple and objective enough for undergraduate work. Each project is subdivided into research units. Each research unit is of such a nature that acceptable results and a report can be expected in 50 laboratory hours, the equivalent of one semester hour of college credit. Each unit is assigned to two or more students in different schools and is reassigned until check results are obtained or the project director is convinced it is not feasible. When sufficient data have been collected the director will report it in a paper for publication, giving full credit to the participating students and their schools.

George Meade has contributed his natural history library and a sum of money to the department of zoology, Tulane University. The library will be incorporated with that of the department to form a nucleus for the continued expansion of the research library, to be called the **Meade Natural History Library.** The microcarding of out-of-print herpetologic materials is now in progress; a limited number of microcards of the following publications are available: George A. Boulenger, *Catalogue of the Amphibians and Reptiles in the British Museum* $17; Egid Schreiber, *Herpetologia Europaea. Eine systematische Beareitung der Amphibien und Reptilien, welche bisher in Europa aufgefunden sind*, $5.

The Veterans Administration has **openings for clinical psychologists** at from $5940 to $10,800 a year. To qualify, applicants must have completed all the requirements for the doctoral degree in a course of study emphasizing psychology. In addition, they must have had at least 2 yr of experience in clinical psychology in a medical setting. Teaching experience in clinical psychology at the graduate level may be offered to meet a part of the experience requirement. Full details and application forms may be obtained from most post offices, or from the Civil Service Commission. Applications will be accepted until further notice and must be filed with the Board of U.S. Civil Service Examiners, Veterans Administration, Washington, D.C.

A series of 20-sec films for use on television has been produced by the **National Society for Medical Research** of 208 N. Wells St., Chicago 6, Ill., and is now being seen on TV stations across the nation. Twenty-two sets of the films are now in distribution and in great demand.

The society's sound and color reel, *Which Fate*, has been reduced to a 20-min film and is now available for loan or print purchase. *Which Fate* tells the story of the stray dog, both as anonymous pound victim and hero of medical research.

Book Reviews

Petroleum Microbiology. Ernest Beerstecher, Jr., Elsevier, Houston, 1954. xv + 375 pp. Illus. $8.

The principles, processes, problems, and possibilities of applying microbiology to the petroleum industry are neatly treated in this book, which deals with much material so new that it is unsettled, speculative, and of a preliminary nature. Beerstecher has assembled and appraised this material in a commendable manner. His writing is lucid, entertaining, and informative. The book appears to be almost free of errors of fact, rhetoric, grammar, or typography. One of the few exceptions is a statement on page 120 to the effect that "it is now well established that the source materials of petroleum are largely composed of marine vegetation, much of which was microbial in nature." The section on bacterial plugging of porous formations is based on reports that are inadequate and partly erroneous.

In the introductory chapter Beerstecher marries microbiology to petroleum engineering by giving a short historical account of the parallel developments of each. Although many vigorous children can be expected from this marriage, a few paragraphs summarizing (for the benefit of petroleum people) the characteristics of microbes and their specialized methods of study and a little more information on the chemical composition and occurrence of crude oil (for the benefit of microbiologists) could have contributed to an earlier understanding.

Except for the section on micropaleontology, which outlines the significance of fossilized protozoans (Foraminifera, Radiolaria, and so forth) and algae (primarily diatoms) as indicators of oil deposits, the book deals mainly with the role of bacteria and allied microorganisms in geologic processes. Chapter II summarizes some of the many contributions of such microorganisms to the biogeochemistry of calcium, carbon, iron, nitrogen, phosphorus, silicon, and sulfur, with particular reference to marine and petroliferous sediments. Although the precise role played by bacteria in the origin of oil is still largely a matter of conjecture and debate, available information leaves little room for doubt that their activities are importantly contributory during the early stages of the process and they could contribute to the maturation, modification, and migration of petroleum.

Most comprehensive and complete are the two chapters dealing with the effects of hydrocarbons upon microorganisms and the effects of microorganisms upon hydrocarbons. Tables and text outline the ecology, characteristics, and oxidation products of numerous microorganisms that can attack virtually all kinds of hydrocarbon, including aliphatic, cycloparaffinic, aromatic, naphthenic, saturated, unsaturated, and substituted compounds. This ability of microorganisms to oxidize hydrocarbons is the basis for beliefs, summarized in Chapter X, that microorganisms might be used as reagents in the petrochemical industry. It is also the basis of various geomicrobiological prospecting methods proposed for employing bacteria or their products as indicators of oil deposits (Chapter V), and for their activities in oil-field flood waters (Chapter VII).

Among the harmful activities of microbes that may be prevented or ameliorated by the kind of knowledge here presented are fermentation of drilling muds (Chapter VI), corrosion (Chapter VIII), and infections of man associated with cutting oils (Chapter XI).

The usefulness of the book is augmented by more than 700 references to relevant literature, a glossary defining approximately 100 microbiological terms and nearly 50 petroleum technology terms, and indexes of authors, microorganisms, and subjects.

CLAUDE E. ZOBELL
Scripps Institution of Oceanography
University of California

Rare Metals Handbook. Clifford A. Hampel, Ed. Reinhold, New York, 1954. xiii + 657 pp. Illus. $12.

Developments in recent years, and particularly since the outbreak of World War II, have led to important uses of many metals that either are very expensive or exist in small quantities. These uses are found in many fields but particularly in nuclear energy, weapons, and instruments. This book should form a valuable addition to the libraries of people working in these fields and should also be of interest to metallurgists in general.

This book is an ambitious undertaking, since 35 different metals are described in addition to the rare earths. The danger in such a work is that the coverage will be inadequate and even inaccurate. The editor has clearly been aware of this and has sought the help of 34 different authors. This amounts to nearly one author for each metal and should assure reliable presentation.

Since the various chapters are by different people, they inevitably vary in style and organization. In general, however, the writing is clear and concise. A description is given of the mineral, its occurrence, and the methods of extraction. Methods of mechanical fabrication are given when these are of interest. Finally, the chemical and physical properties of the metal and its principal uses are described.

The last chapter, "Physical properties of metals," brings together values of all the usual physical constants into a series of tables. In addition, it lists nuclear cross-sections and prices as of 1953. This chapter is not limited to rare metals but includes the common ones as well.

This volume is a much-needed contribution to the metallurgical literature.

J. H. FRYE, JR.
Metallurgy Division, Oak Ridge National Laboratory

Méthodes et Réactions de L'Analyse Organique. Leon Velluz, Ed. vol. III: *Réactions Colorées et Fluorescences.* Maurice Pesez and Pierre Poirier. Masson, Paris, 1954. 297 pp. Paper, F. 2750.

This is the third, and last, volume of the treatise edited by L. Velluz under the general title *Méthodes et Réactions de L'Analyse Organique.* In essence, this book is a compilation of qualitative tests for various well-known kinds of organic compounds. Both organic and inorganic reagents are used to produce colored (fluorescing products.

Reactions are arranged under nine types, such as oxidation-reduction and diazotization-coupling. Under each of these, consideration is given to the action of various reagents, such as heteropoly compounds and ferric chloride, on different classes of compounds, such as alcohols and phenols.

Under principles of the reactions is a brief explanation of the chemistry involved, with many references. Following brief directions for performing the tests in each section are tables summarizing the reactants covered, the relevant references, and certain other information, such as the color produced.

In summary, this seems to be a useful collection of widely scattered information on the color-forming possibilities of many systems. I have already found valuable suggestions during a brief examination of the book. The wealth of references provides access to any needed details for specific cases.

M. G. MELLON

Department of Chemistry, Purdue University

Theory of Games and Statistical Decisions. David Blackwell and M. A. Girshick. Wiley, New York; Chapman & Hall, London, 1954. xi + 355 pp. Illus. $7.50.

The mathematical theory of decision making has received increasing attention in recent years. The uses of the art of making optimal judgments according to various criterions occur in many fields of scientific endeavor, including economics, military tactics, business, and engineering, to cite a few examples.

To motivate the subject historically, it began when J. von Neumann and O. Morgenstern in a fundamental book presented an approach to some of the problems of economics based on a new mathematical theory called *The Theory of Games and Economic Behavior,* published in 1945. Later A. Wald, a noted statistician, recognized the relevance of game theory to statistics and exploited some of these concepts. He published a synopsis of his investigation in a book entitled *Decision Theory.* And now this book by D. Blackwell and M. A. Girshick attempts in a thorough manner to develop all the connecting concepts of decision theory and the theory of games.

The mathematical model for decision theory is a special case of that of game theory in which the statistical problem can be viewed as a contest between the statistician and nature. The precise relationship is developed in detail throughout this work. Almost all types of statistical analysis, such as testing hypotheses, estimating unknown parameters, prediction, and discrimination are cast in this framework

The first two chapters are devoted to an exposition of some of the basic elements of game theory to be used in the sequel. In Chapter 3 the statistical game is defined, and many of the motivating ideas are introduced. From here on a careful analysis is presented, instance, of the situation in which the number of actions available to the statistician or the number of states of nature is finite. All this theory is based on the circumstance of a fixed experiment that is to be performed and the statistician desiring to choose the best course of action. Following this special treatment the authors give a thorough analysis of statistical decision theory involving no predetermined number of observations on the part of the statistician. Allowance is made for the possible performance of an infinite number of experiments with the element of cost of experimentation presenting a deterrent. The last two chapters study various aspects of estimating unknown parameters and the problem of when is one experiment more informative than another.

This book is filled with many exercises and can be used as a textbook on the graduate level. In this attempt to attract the student of statistics, as well as the professional, to this modern viewpoint of statistical theory, nowhere in the work are any of the basic ideas underlying the theory sacrificed. Although this was intended primarily as a textbook in decision theory, it contains many sections of new research and hence it can also serve as a source book for future investigations. This book will certainly occupy a fundamental place in this growing field of mathematics, statistics, and the general theory of strategy and its applications.

SAMUEL KARLIN

Department of Mathematics,
California Institute of Technology

Physical Properties of Solid Materials. C. Zwikker. Interscience, New York; Pergamon, London, 1954. viii + 300 pp. Illus. + plates. $8.75.

This book treats in some form most of the properties of solids. Written on an intermediate level, it is a mixture of textbook and reference book. For the most part it is devoted to presentations of experimental facts and accompanying explanations. Formal development of theory is limited to that essential for these explanations. For its avowed purpose—an inclusive summary—it is satisfactory.

The first thing that strikes the reader is the great breadth of topics considered. Few areas of the field are completely omitted (indeed, in the author's preface there is a refreshing absence of an apology for omitting this or that topic, and, in fact, none is necessary). Clearly, then, in a book of rather average length no given topic may be treated at great length. For example, in few places are alternate interpretations of

facts presented. This at times results in the author's taking a stand on some controversial point that may in the end be wrong. Zwikker is apparently willing to risk this for the sake of conciseness.

Broadly speaking, the book develops the field in the standard way. First appear introductory chapters on binding forces and lattice types along with discussion of homogeneous and heterogeneous mixtures. Then follows a good treatment of the anisotropic properties of crystals. In brief, it proceeds from the simple scalar-vector properties (for example, pyroelectricity) to the more complicated tensor-tensor properties (as far as elasticity). This section is the best in the book. After brief discussions of damping (mechanical and dielectric) and plasticity, there follow several chapters on thermal properties and finally several chapters on electron properties.

For its purpose it is well constructed and well illustrated with many line drawings and graphs. It is especially notable for the extensive use of scales to present experimental data concisely. It is written in a good style, although here and there the deletion of one or another "effect" in favor of a section tying together more tightly the previously mentioned "effects" might be advantageous. Successful use of this as a classroom textbook will require frequent use of the many original papers referred to. Perhaps for a student its best use will be its aid in reviewing for comprehensive examinations.

CHARLES WERT
Department of Mining and Metallurgical Engineering, University of Illinois

Elementary Introduction to Molecular Spectra. Børge Bak. North-Holland, Amsterdam; Interscience, New York, 1954. 125 pp. Illus. $2.90.

This little book is intended for biologists, chemists, and chemical engineers who increasingly resort to empirical applications of molecular spectroscopy for the solution of their problems and naturally have a desire to understand the phenomena they apply. Such understanding is not easily achieved, however, for the dynamics of molecules and their interaction with electromagnetic radiation are intricate quantum-mechanical processes, and the classification of spectral data is based on group theory. Thus, the author has undertaken a difficult task.

The first chapter is an introductory survey of practical and theoretical spectroscopy. In the second chapter the basic postulates of quantum mechanics are stated, and an outline is given of the derivations of some of the equations used in molecular spectroscopy. The remaining three chapters give a clear and readable account of microwave, infrared, and visible-ultraviolet spectra. Because of the severe limitation of space, many important matters are omitted or treated with extreme brevity (only four pages are devoted to Raman spectroscopy!), and some oversimplifications have resulted. These chapters have been wisely written in such a manner that they are independent of Chapter II. This is particularly fortunate because, in my opinion, this chapter is the least successful. The Hamiltonian operator is introduced in a manner reminiscent of the Danish flag, which, according to legend, fell down from heaven. Moreover, very few of the expressions used in the later chapters are derived, and only for the particle in a box is the derivation approximately complete. A discussion of Bohr's concept of stationary states, with which the theory of spectra began, would be more helpful to the reader than the two tables of hydrogen wave functions.

Despite its shortcomings, which are closely related to its brevity, this book should be valuable, not only to its intended readers, but also to students who desire a quick preview of molecular spectroscopy.

J. RUD NIELSEN
Department of Physics, University of Oklahoma

Geschichte der Mathematik. J. E. Hofmann. Walter de Gruyter, Berlin, 1953. 200 pp. DM 2.40.

This small volume is the first of several giving a brief but thorough sketch of the history of mathematics. It covers the period from the beginnings of mathematics up to the appearance of Descartes and Fermat. The author treats the mathematics of the ancient world with relative brevity and concentrates on the mathematical accomplishments of the medieval world. Although the names of practically everyone who made any contribution to mathematical knowledge are here, Hofmann can do little more than list them. Nevertheless several figures among the ancient and medieval mathematicians have been singled out for detailed treatment.

This book has excellent bibliographic material, ranging from references to works of general cultural history to original textbooks used in the period discussed. In addition, there is an index of the mathematicians mentioned with bibliographic information for each. These features contribute to the usefulness of this as a reference book as well as for a quick review. However, it is far too dull and sketchy for the general reader.

PHILIP RABINOWITZ
National Bureau of Standards, Washington, D. C.

Précis de Minéralogie. P. Lapadu-Hargues. Masson, Paris, 1954. 311 pp. Illus. + plates. Cloth, F. 2200; paper, F. 1700.

The purpose of this small book, as stated in the preface, is to interest students and scientists concentrating in other fields in the general aspects of descriptive mineralogy. The first section is very brief in its description of the concept of a mineral and the methods that are used to characterize them. The major portion of the book is devoted to the descriptive mineralogy, which classifies approximately 350 species.

While the pattern of other older familiar works on descriptive mineralogy predominates, the author has strived to introduce into the descriptive section mate-

rial concerning mineral structures and relationships which have been discovered by modern physical and chemical methods in recent years. He pays special homage in an eloquent epilog to the contributions made by x-ray diffraction and crystal structure analysis. On the whole, the work still retains the classical lines of descriptive mineralogy of 30 years or more ago, with the new material inserted as glosses on this basic pattern. There is such an enormous wealth of knowledge about the structure and physical and chemical behavior of minerals available today—which goes far toward explaining the most baffling problems of mineralogic paragenesis and phase relationships as well as explaining the specific behavior of the minerals themselves—that it is a disappointment not to see much more incorporated in this book.

There are many defects and errors that mar the text. The structural information is not of recent date: for example, the mixed SiO_4 and Si_2O_7 groups in idocrase are not mentioned, while a ninefold ring structure (Si_9O_{27}) is suggested for tourmaline. Many very rare species are described and classified, but several common species are not mentioned at all, such as epsomite, colemanite, apophylite, prehnite, turquoise, and ice. There is no discussion of crystal symmetry; the long obsolete Levy symbols are used throughout; and the crystal figures are very poorly drawn. There is not a single reference to another book or paper.

It is to be hoped that the commendable plan of a work on mineralogy designed for the interest of scientists in general will be better fulfilled in future editions or issues.

HOWARD T. EVANS, JR.

U.S. Geological Survey

Guide for Safety in the Chemical Laboratory. General Safety Committee of the Manufacturing Chemists' Association. Van Nostrand, New York, 1954. xiii + 234 pp. Illus. $4.25.

The publication of this book should satisfy the needs of laboratory staff members, instructors, and laboratory designers for a safety manual directed specifically toward problems that arise in chemical research and development.

Some sections of the book—the chapters that treat chemical hazards, toxicity, pressure vessel hazards, and personal protective equipment—are useful and even interesting reading for the experimenter. A pedagogical tone, perhaps impossible to avoid, is evident in other serviceable chapters that deal with everyday operations—for example, the danger of leaning too far backward (in swivel chairs) is pointed out. The discussion of hazards encountered in experimentation with radioactive substances should serve as an introduction to the subject for one who is considering doing such work. The chapter on specialized phases of first-aid and treatment was prepared by a medical committee and should be of interest to physicians as well as to laboratory workers.

References are given in the text and in a table. Other tables on toxicity and flammability and a complete index are included. The usefulness of this book would be increased if supplementary bibliographic material were added, especially for the sections that are of an introductory character.

MORRIS L. PERLMAN

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An Introduction to Climate. Glenn T. Trewartha. McGraw-Hill, New York–London, ed. 3, 1954. vii + 402 pp. Illus. + maps. $7.

In 1936 Finch and Trewartha published a textbook of nearly 800 pages entitled *Elements of Geography.* It was a very useful book because it was a survey of the whole field of geography, although the emphasis was uneven. The first and major part of the book dealt with the natural elements of landscape; the first several chapters were grouped into two sections under the titles "Elements of weather and climate" and "The climatic types and their distribution." The next year Trewartha revised and expanded these two sections somewhat and published them in a separate book entitled *An Introduction to Weather and Climate.* Trewartha explained that it was avowedly introductory in character; he treated the subject from the climatic rather than the meteorologic point of view and laid no claim to completeness. It was written as a textbook at college level for use in geography departments. It was a popular book and, after 6 years, was revised and reprinted.

Now, after 11 years, another edition has appeared, with the shortened title *An Introduction to Climate.* The organization is the same as that in earlier editions, but the fact is unmistakable that a great deal of work has gone into the revision. Large sections were rewritten in order to bring the discussion into harmony with more recent materials and points of view. There is an entirely new chapter on climatic classification. Many new illustrations have been added, and many of the old ones were revised or redrawn. Like the earlier editions, this book consists of two parts: Part I emphasizes the systematic aspects of climatology and part II the regional features as revealed in the world pattern of distribution.

The book was written by a geographer for geographers. The author emphasizes description and distribution but attempts to introduce sufficient background on the physical processes of the atmosphere to make the patterns of climatic distribution intelligible. It is his conviction that a climatology that omits, or seriously slights, genesis and explanation is not only dull but also inadequate for geographers' needs. Actually, to present the substance of physical climatology adequately to students who have had neither physics nor mathematics is impossible. Therefore, the explanation is necessarily largely geographic and descriptive rather than physical, and as such is mere garnish.

There is no real reason why we should have one climatology for geographers and another for meteor-

ologists. What is needed is a textbook that does not shy away from mathematical equations and physical theory but includes everything needed and insists that the student be properly prepared before he attempts to master the field. This is not such a book. The author is probably even now at work on the revisions for the fourth edition. It would be a great day for geography, meteorology, and climatology if he were to adopt a completely uncompromising position and write the book that needs to be written, leaving it to the student to prepare himself as he should for using it.

C. W. THORNTHWAITE
Johns Hopkins University Laboratory of Climatology

Directory of Hydrobiological Laboratories and Personnel in North America. Robert W. Hiatt, Ed. Univ. of Hawaii Press, Honolulu, 1954. ix+324 pp. Illus. $3.75.

A listing of 187 laboratories, this directory gives for each laboratory the senior officer, institutional affiliation, objectives, scope of activities, season for operation, and environments stressed. Major research facilities, capital equipment, and provisions for publication are indicated. Instructional programs, teaching facilities, scientific staff, and accommodations available are described. Biographical sketches of 1300 personnel give institutional affiliation, mailing address, field of specialization, current research project, and field experience by geographic region. Data for all laboratories are broken down into a treatment of inland laboratories and coastal laboratories and finally segregated by geographic area.

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Role of the Pituitary in Cancer. The clinical value of piuitary lipid treatment. Henry K. Wachtel. William-Frederick Press, New York, 1954. 31 pp. $2.

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Field Investigation of Wave Energy Loss in Shallow Water Ocean Waves. Tech. Memo. No. 46. Charles L. Bretschneider. Beach Erosion Board, Corps of Engineers, Dept. of the Army, Washington 25, 1954. 42 pp.

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Escape to Freedom. The story of the U.S. escapee program. Foreign Operations Administration, Washington 25. 22 pp.

Studies in the Ecology of the Narrow-Mouthed Toad, Microhyla Carolinensis Carolinensis. Tulane Studies in Zoology, vol. 2, No. 2. Paul K. Anderson. Tulane Univ., New Orleans, 1954. 32 pp. 50¢.

The General Agreement on Tariffs and Trade. Negotiations under the Trade Agreement Act of 1934 as amended and extended. Dept. of State Publ. 5653. Prepared by Interdepartmental Trade Agreement Organization. Dept. of State, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 40 pp. 20¢.

On the Biology of Some Javanese Loranthaceae and the Role Birds Play in Their Life-History. Beaufortia, vol. 4, No. 41. W. M. Docters Van Leeuwen. Zoological Museum, Amsterdam, 1954. 102 pp.

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Technical Papers

Dammar and Mastic Infrared Analysis

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Recent interest in the identification of natural resins used in the fine arts chiefly concerns the application of paper chromatography (*1*). The use of infrared spectroscopy for this purpose has not been extensively treated. Hanson (*2*) recently reported spectra for dammar and East India Pale, in conjunction with the analysis of mediums once used by J. M. W. Turner. Elizabeth Jones (*3*) at the Fogg Museum, Harvard University, used infrared analysis to study the softening of aged films under the action of solvents, although spectra were not reported. This paper discusses the identification, by infrared spectroscopy, of dammar and mastic, resins of considerable interest in the study of paintings in oil.

Absorption of dammar and mastic was measured in films cast from resins dissolved in chloroform (Fig. 1). The curve for dammar is similar to that reported by Hanson. The curve for mastic is practically identical, except for lack of absorption at 890 cm^{-1}. This band, apparently the same as that reported at 897 cm^{-1} by Hanson, is perhaps the most significant difference between the absorption of these two resins, which are the most commonly used for the final picture varnish. The absorption at 760 and 1220 cm^{-1} is attributed to chloroform. The presence of residual solvent is not expected to alter the spectra. Samples dried overnight under high vacuum were compared with samples dried at room conditions for 10 min. No alteration in the spectra of the resins was noticed, although the adsorption of chloroform at 760 cm^{-1} decreased from 100 to 65 percent.

The curves of good and poor grades of mastic and dammar, the poor grades being more intensely colored, were practically identical. Samples of recently purchased Batavia and Singapore dammar were practically the same, as was a sample of Batavia dammar that had been in stock for about 35 yr. These similarities are not entirely unexpected since the two resins contain mixtures of several components representing much the same class, that is, resinols, resin acids, essential oils. This situation makes it much more difficult to obtain a "characteristic" spectrogram. Their remarkable similarity is emphasized by the fact that the spectrum of sandarac and that reported for East India Pale are readily distinguishable. The resins are also more similar in physical properties than is generally assumed (*4*). Mills and Werner have likewise reported similarities in the chromatograms.

The work of Jones demonstrated that the decreased ease of solubility of dammar and mastic, noticed upon aging, is in part due to a physical change rather than, for example, to the formation of crosslinked bonds. However, some oxidation probably does take place with age, accompanying the well-known discoloration of these resins. In experiments in this laboratory a gain in weight was indeed detected. To determine to what extent these changes are detected by infrared analysis, spectra were taken of samples exposed for 200 hr in a Fade-O-Meter (National Accelerated Fading Unit, Type XV). Samples on window glass were air-dried several weeks. Several were baked for 3 days at 70°C to drive off most of the solvent before exposure. No essential difference in the behavior of the two types of samples was noticed. The samples attained a temperature of about 55°C in the Fade-O-Meter. Comparative tests at this temperature indicated that serious deterioration was largely dependent on the ultraviolet radiation rather than upon temperature alone.

Scrapings of the badly cracked and discolored resins were cast from chloroform solution as before. Despite severe physical deterioration, the spectra of the exposed samples were quite similar to the unexposed. For both resins, however, there occurred loss in detail between 800 and 1200 cm^{-1}. This would tend to indi-

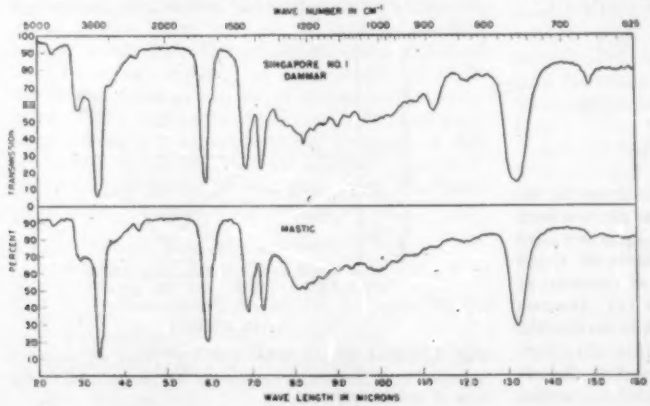

Fig. 1. Transmission as a function of wave number or wavelength.

cate a greater mixture of absorbing components in the aged material. In mastic, the methyl band at 1375 cm^{-1} is less intense than the methylene band at 1450; in the aged resin the intensities were reversed. This finding may be explained in two ways. If the intensity of absorption per methyl or methylene group remained constant, then there may have been an increase in the relative number of methyl groups (as by chain termination) or a decrease in the relative number of methylene groups (as by oxidation). Alternatively, the intensity per group might alter, implying a change in molecular environment in the immediate vicinity. No matter which effect may be at work, a chemical change is reflected. However, because carbonyl and carboxyl groups are present in relatively large amounts in the initial resins, marked change and ready analysis are not immediately forthcoming. Considering the relatively slight change in spectra after severe deterioration, the consistency in the spectra of very old samples and "poor" grades is not surprising.

Infrared analysis is known not to be sensitive in the analysis of trace materials and is not particularly adapted to the study of extensive mixtures. In the examination of materials used in the fine arts, these factors will limit the effectiveness of the method. The great similarity of the spectra of dammar and mastic, an important pair, draws special attention to the problem.

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* Fellowship on artists' materials sustained at Mellon Institute by the National Gallery of Art, Washington, D.C. I am indebted to F. A. Miller, Department of Research in Chemical Physics, Mellon Institute, for the infrared spectra and their interpretation.

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15 September 1954.

Antiperoxidative Action of the Cobaltous Ion and Its Consequences for Plant Growth

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The cobaltous ion is known to cause dramatic increases in the rate of growth of several plant tissues that have in common a marked sensitivity to red light (*1, 2*). Co^{++} is also known to protect brain tissue against damage caused by high levels of oxygen (*3*) and mice against x-irradiation damage (*4*). The two injurious effects on animals are believed to involve the formation of free radicals and peroxides (*5*), Co^{++} apparently affording protection by negating the effects of these substances. We believe that the action of Co^{++} on plant growth is explicable in similar terms.

We have previously shown (*6*) that Mn^{++} increases the apparent rate of peroxide genesis in etiolated pea tissues, leading to increased peroxidative destruction of the plant growth hormone indoleacetic acid (IAA) by the IAA-oxidase system (*7*), and thus to a decreased growth rate. The Co^{++} ion, however, works in the reverse direction, decreasing peroxigenesis, thus sparing IAA and increasing growth.

The root systems of 3-day-old Alaska pea seedlings were utilized in these experiments (*8*), and peroxide genesis was measured by two independent methods. The former is based on the peroxidative conversion of pyrogallol to purpurogallin (*6*), and the latter is based on the peroxidative destruction of IAA (*7*). Since both tests are performed in the absence of exogenous H_2O_2, the amount of endogenously produced peroxide can be deduced from the amount of peroxidation accomplished.

The data of Fig. 1 show that $10^{-4}M$ Co^{++} (supplied as $CoCl_2 \cdot 6H_2O$) decreases the rate of IAA destruction by about 20 percent, while $3 \times 10^{-5}M$ Mn^{++} (also supplied as the chloride) increases IAA destruction by about the same percentage. Similar data may be obtained with pyrogallol as the substrate and have been interpreted as meaning that Mn^{++} raises and Co^{++} depresses the effective peroxide level of the cell.

The toxic effect of 100-percent oxygen and its negation by Co^{++} may also be shown with pea roots. Excised roots were incubated either in $2 \times 10^{-4}M$ IAA buffered at *p*H 6.1 or in $0.005M$ pyrogallol buffered at *p*H 4.5. With each substrate, various Co^{++} and Mn^{++} concentrations were introduced. The vessels were shaken at 30°C in a stream of pure oxygen. The data, shown in Table 1, demonstrate clearly that Mn^{++} enhances and Co^{++} depresses peroxigenesis, as measured by the oxidation of either substrate.

Control roots that had been exposed to pure oxygen for 5 hr were greatly injured, as was shown by their failure to float on the medium, their yellow color, their extreme transparency, their jellylike consistency (Fig. 2), and the extreme turbidity of the medium. The development of these symptoms of injury was almost completely prevented by the inclusion in the medium

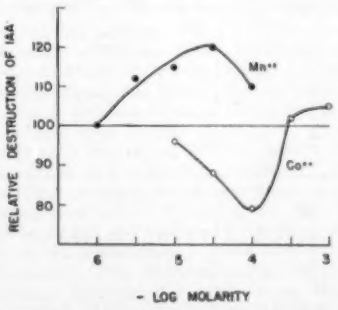

Fig. 1. Effect of the Mn^{++} and Co^{++} ions on peroxide genesis in pea tissues, as measured by the rate of oxidation of indoleacetic acid.

Table 1. Effect of Co^{++} and Mn^{++} on peroxide genesis in pea root tissues incubated in 100-percent oxygen, as measured by purpurogallin formation and IAA oxidation.

Medium		Pyrogallol oxidized per 100 mg fresh wt. in 5 hr		IAA oxidized per 100 mg fresh wt. in 5 hr	
Co^{++} (M)	Mn^{++} (M)	μM	Relative	μM	Relative
0	0	0.860	100	0.133	100
0	10^{-6}	1.270	148	.185	139
0	10^{-5}	1.000	116	.144	108
0	10^{-4}	1.020	117	.139	105
10^{-5}	0	0.750	87	.115	86
10^{-4}	0	.612	71	.097	73
10^{-3}	0	.500	58	.060	45

Fig. 2. Damage to excised pea roots by 100-percent oxygen and its prevention by $10^{-3}M$ $CoCl_2$. Translucency indicates damaged condition. Left, air, no cobalt; middle, pure oxygen, no cobalt; right, pure oxygen, $10^{-3}M$ $CoCl_2$.

of $10^{-3}M$ Co^{++}, a concentration that reduces peroxigenesis to about half the control rate (Table 1).

The multiple effectiveness of Co^{++} in reducing apparent peroxigenesis, curtailing IAA destruction, preventing oxygen damage, and preventing x-irradiation damage suggests that these phenomena are related, and that decreased peroxide levels can account for the prevention of injury. The fact that Co^{++} similarly mimics the effect of red light in promoting the growth of certain plant cells (*1*) suggests further that the morphogenetic action of such red light is somehow associated with peroxide metabolism, perhaps through the IAA-oxidase system. The exact mechanism of action of the cobaltous ion, as yet unelucidated, may involve either a depression of the rate of peroxide genesis in the cell or a decomposition of peroxides as they are formed and before they are utilized in peroxidative reactions. Such Co^{++}-initiated chain decompositions of hydroperoxides are well known (*9*).

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12 August 1954.

Serial Sections for Electron Microscopy

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New microtomes (*1*, *2*) enable the operator to cut sections for electron microscopy only a few hundred angstroms thick, permitting lateral resolution of the order of 40 A or better. It is difficult to infer from single ultrathin sections, however, the three-dimensional structure of the cell or its organelles. To reconstruct unknown cellular structures in three dimensions, it seems essential to obtain and examine serial sections. All the microtomes in current use produce ribbons of sections, which float from the knife edge onto the surface of a liquid in a collecting trough. The problem is to pick up the ribbons and align them on the electron-microscope grid so that the material to be studied is not obstructed by the bars.

This report (*3*) describes methods for picking up ribbons of serial sections with a Formvar-coated wire loop, and then placing them over the slits in Sjöstrand-type specimen holders (obtained from Smethurst, High-Light, Ltd., Sidcot, Lanes., England). By this procedure any desired number of serial sections can be collected routinely and examined in the electron microscope. The electron micrographs in Fig. 1, representing 18 serial sections through the endoplasmic reticulum of the cytoplasm of a salivary-gland cell from the larva of *Drosophila melanogaster*, were made by this method, which is described here.

The tissue is fixed in 1-percent buffered osmium tetroxide and imbedded in n-butyl methacrylate (*4*). The methacrylate block is trimmed (*1*) under the dissecting microscope as close as possible to the desired cells, to leave a surface rectangle about 0.3 by 0.08 mm. This block is oriented in the microtome with its long dimension parallel to the knife edge, and when sectioning is begun a straight ribbon is usually obtained.

After 15 to 25 sections have been cut, the ribbon has to be detached from the knife edge. This is facilitated by the use of a trough (Fig. 2) in which the liquid level can be controlled by manipulation of a hypodermic syringe connected by a plastic tube to an opening in the base of the trough. The level of the liquid is raised above the knife edge to form a well-rounded meniscus, and the ribbon is detached with a fine hair. The ribbon of sections is then floated from the shallow liquid near the knife edge to a deeper part of the trough. It is removed from the liquid in the following way.

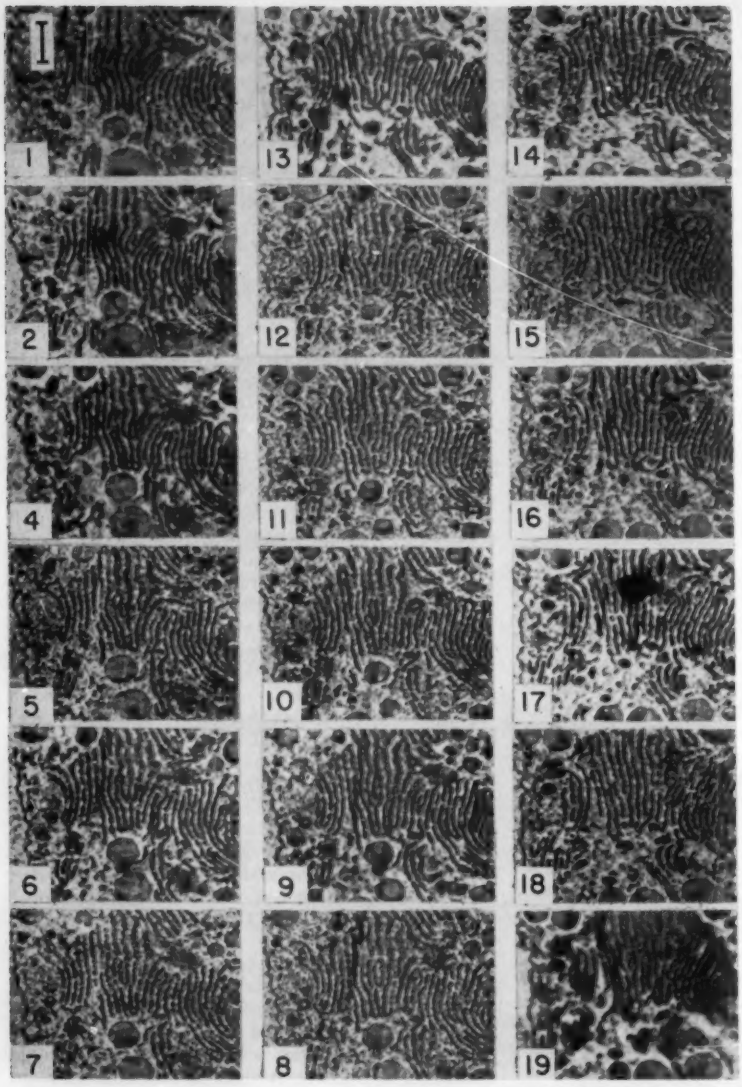

Fig. 1. Eighteen serial sections through a salivary-gland cell of a larva of *D. melanogaster*, which had been fixed for 15 min in 1-percent buffered osmium tetroxide, pH 6.5, and imbedded in n-butyl methacrylate. The third section has been omitted because it was wrinkled. It is estimated that the 19 sections represent a total thickness of 1 to 2 μ. The magnification is indicated by a 1-μ bar superimposed on the first section.

The implement used consists of a thin film of Formvar supported by a small loop (about 4 mm in diameter) made of 0.006-in. "Advance" wire (43 percent nickel, 57 percent copper). The wire loops are placed on the surface of a Formvar film floating on water, and the whole film with the attached loops is picked up onto a glass slide. When dry, these Formvar-coated loops are separated and used for collecting the ribbons. A loop is inserted into the liquid of the trough at a 45- to 90-deg angle (Fig. 2), and the ribbon is centered across its diameter. As the loop is raised slowly from the trough, the sections adhere to the Formvar.

After the desired serial sections have been collected on the Formvar-coated loops, the ribbons are transferred to supporting grids for examination in the electron microscope. This is accomplished under low-power magnification of a compound microscope equipped with a condenser mount that can be elevated. The special equipment used consists of a transparent plastic assembly (Fig. 3*e*, *f*) designed to fit into the condenser mount and to support a Sjöstrand-type grid *h* on top of a Lucite rod *e* ⅛ in. in diameter, and a circular disk *d*, 10 cm in diameter with a central opening 10 mm in diameter, which rests on the microscope stage *b* and serves to support the loop *g*

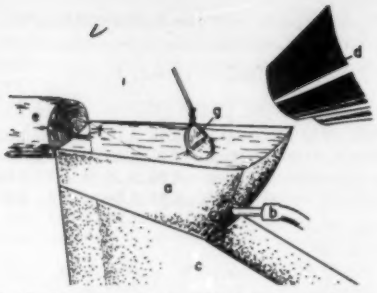

Fig. 2. Equipment used to collect serial sections: *a*, collecting trough; *b*, plastic tube connecting the trough with the hypodermic syringe; *c*, glass knife; *d*, dissecting microscope; *e*, methacrylate block; *f*, ribbon of serial sections; *g*, Formvar-coated loop

holding the sections. The loop is attached to the disk so that the sections are located in the center of the opening. By manipulation of the disk on the microscope stage, the ribbon of sections is optically superimposed over a slit in the grid. The condenser mount is raised to bring the grid and the Formvar film into contact; further elevation causes the rod with the grid to pass through the wire loop. The Formvar film, including the sections located over one of the slits of the grid, is firmly attached in this manner to the surface of the grid. The uninterrupted ribbon of sections is then ready for examinations in the electron microscope.

The electron micrographs in Fig. 1 show such a series of sections cut with a Porter and Blum (*1*) microtome and mounted on a single grid. These 18 sections, representing a total thickness of less than 2 μ, demonstrate the potentialities of using serial sections for determining the three-dimensional distribution of cytoplasmic structures such as the endoplasmic reticulum and secretion granules. For example, a single cross section of the endoplasmic reticulum shows lines that might be thought to represent either isolated fibrils or walls of tubules. In serial sections, however, the double lines may be followed from section to section indicating that they represent membranes making up a complex structure of interconnected curved lamellae. Gaps in these lines suggest holes in the membranes. The serial sections of Fig. 1 also reveal that the secretion granules are essentially spherical: the progressive changes in diameter in succeeding sections, such as can be seen in the two granules at the bottom of sections 1 to 13, indicate a succession of cuts through a radially symmetrical object. These examples illustrate the usefulness of serial sections in working out the three-dimensional relationships of newly observed cellular constituents whose structure is not obvious in individual sections.

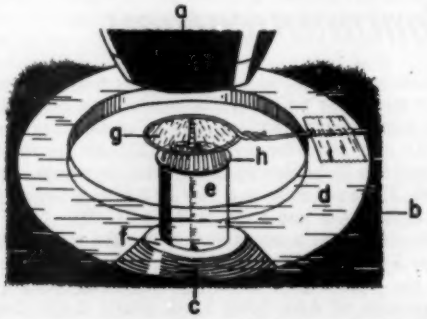

Fig. 3. Equipment used to transfer the serial sections to a Sjöstrand grid: *a*, microscope objective lens; *b*, microscope stage; *c*, condenser; *d*, large plastic disk; *e*, ⅛-in. plastic rod; *f*, plastic disk to support rod; *g*, loop with serial sections; *h*, Sjöstrand grid.

Another advantage of serial sectioning for electron microscopy is that it will aid in locating specific constituents within cells, which in the past has been a matter of chance. The method described here will permit collection of serial sections through an entire cell. Only a few of these need be examined to select the particular sections containing the organelle of special interest for intensive three-dimensional study.

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* Lalor Foundation fellow, University of Pennsylvania. Grateful acknowledgment is made to the Lalor Foundation. Present address: Department of Genetics, Carnegie Institution, Cold Spring Harbor, L.I., N.Y.

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14 September 1954.

Theoretical Rate Equation for World-Record Running Speeds

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Lietzke (*1*) has reviewed the various attempts that have been made since 1905 to formulate a mathematical description of the time-speed-distance relationships in world-record performances. In the most recent of these, Francis in 1943 used a semilogarithmic hyperbola (*2*) for the distance range ¼ to 10 mi. Lietzke did not think the fit was satisfactory and returned to the simple 1905 parabola with a revision of the curve constants. He has been remarkably successful in applying this curve (distance = at^2) to the known records for walking, running from 880 yd to the 26-mi marathon, swimming, and both horse and automobile racing. Nevertheless, his equation does not hold for the shorter distances in either swimming or running, and the rate equation he derives from it, for human running, does not fit the observed values closely for any distance range. His rate curve is therefore a smooth curve between the observed points and is not a graph of the equation.

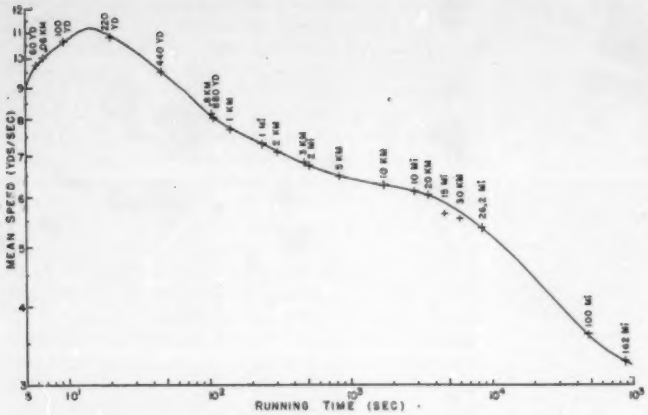

Fig. 1. Rate vs. time curve for 1954 world records in running.

Table 1. Curve constants.

Item	a (yd/sec)	k (sec)	Half-time
Energy loss	−13.10	2.48×10^{-1}	2.79 sec
Alactate	4.80	2.53×10^{-2}	27.4 sec
Lactate	1.70	3.45×10^{-3}	3.35 min
Glycogen	2.96	5.88×10^{-5}	3.27 hr
Fat, etc.	3.64	1.234×10^{-6}	6.5 days

It can be postulated that the maximum speed in running is limited by the energy reserves available for conversion into work, and that each of these resources begins to be depleted from the very beginning of the race in accord with an exponential law. These resources consist of the alactate and lactate oxygen debts, the glycogen reserve, body fat, and eventually body protein.

Also to be considered is the energy-loss factor, proportional to speed, that was at one time thought to be due to muscle viscosity. It is now known that the loss must be explained in more complicated terms. However, it is possible to represent this factor as a simple exponential term carrying a negative sign (*3*).

The available data do not permit an estimate of the role of protein depletion as an energy source in running, but it is doubtful that it is quantitatively important under ordinary circumstances. The rate of depletion of the other energy sources can be guessed at from various types of information—the half-times would be expected to be several days for fat, several hours for glycogen, 3 to 5 min for the lactate debt, and about 30 sec for the alactic debt.

Figure 1 shows a log-by-log plot of the equation

$$dy/dt = a_1e^{-k_1t} + a_2e^{-k_2t} + a_3e^{-k_3t} + a_4e^{-k_4t} + a_5e^{-k_5t},$$

using the curve constants given in Table 1. It will be observed that each of the rate coefficients k is of a different order of magnitude. It may also be noted that a parabolic rate equation would plot in a straight line in this figure. Details of the method of curve-fitting and explanation of the time constants are being published elsewhere (*4*).

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7 September 1954.

Comments and Communications

Avelinoite, a New Hydrous Sodium Ferric Phosphate Mineral from Minas Gerais, Brazil

Avelinoite, a hydrous sodium ferric phosphate, is the sixth new phosphate mineral described since 1949 from the granite pegmatite at the Sapucaia pegmatite mine, Minas Gerais, Brazil. [See *Science* **119**, 739 (1954) and Am. Mineralogist **34**, 541 (1949); **38**, 263, 1126 (1953)]. The mineral is named in honor of Avelino Ignacio de Oliveira, eminent Brazilian geologist and director of the National Department of Mineral Production, Rio de Janeiro.

Avelinoite occurs as yellow well-formed crystals, less than 1 mm in length, on cavity walls in altered phosphate, principally frondelite. Its specific gravity is 3.08 and its optical properties are: uniaxial, negative; $\omega = 1.803$; $\varepsilon = 1.769$. The crystals are assigned to the tetragonal pyramidal class. The basal pinacoid {001} and 1st-order pyramid {113} are prominent forms; the 2nd-order pyramid {012} is poorly developed. The axial ratio is $a : c = 1 : 2.650$; ρ (calc.) for {012} is 52°58′ and ρ for {113} is 51°20′.

Single crystal x-ray studies define the space group to be $P4_1$ (C_4^2). The cell size is $a_0 = 7.32$, $c_0 = 19.4$ A. On the powder pattern strong reflections occur with d-spacings of 4.85, 3.60, 3.186, 3.101, 2.913, 2.658, 2.209, 2.181, and 2.020 A. The unit cell contains $Na_4Fe_{12}^{III}(PO_4)_8(OH)_{16} \cdot 8H_2O$.

The chemical analysis shows: Na_2O, 4.70; K_2O, 0.63; MnO, 0.99; CaO, 0.10; FeO, none; Fe_2O_3, 47.87; Al_2O_3, 1.36; P_2O_5, 29.06; H_2O, 14.45; insol.,

1.04; *total*, 100.20 percent. The analysis, minus the insoluble residue and recalculated to 100 percent, compares favorably with the idealized formula $NaFe_3^{III}(PO^4)_2(OH)_4 \cdot 2H_2O$.

Wardite was recently shown to have the formula $NaAl_3(PO_4)_2(OH)_4 \cdot 2H_2O$ [Hurlbut, *Am. Mineralogist* 37, 849 (1952)]. Avelinoite, isostructural with wardite, is another example of substitution of trivalent iron for aluminum in a known mineral structure.

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23 November 1954.

A New and Physicochemically Well-Defined Group of Tumor-Promoting (Cocarcinogenic) Agents for Mouse Skin

In the course of our studies on the mechanism of experimental skin carcinogenesis [carried out since 1945; some of our previous papers are quoted in (*1*)], we have employed, as an aid, chemically and physicochemically well-defined nonpolar-polar substances as vehicles for the carcinogenic hydrocarbons. Some of these were naturally occurring, biologically active compounds; others were synthetic lipophilic-hydrophilic products, such as detergents and high polymers, especially carbowaxes (*2*). These substances were chosen by us partly because they have their principal counterparts in the living matter, and partly because these lipophilic-hydrophilic substances form a large group of well-defined compounds which, in regard to their physicochemical nature, can be arranged in systematic series. In addition, the interaction between certain nonpolar-polar compounds and biologically important proteins has been extensively investigated *in vitro* and partly also *in vivo* and constitutes now a fairly well-known field (*3*).

During our studies it appeared that some of these nonpolar-polar compounds—when used as carriers for the carcinogen—on the one hand delayed the development of tumors, whereas others greatly enhanced it and, on the other hand, caused different types of morphologic skin alterations. Therefore, and because the most powerful cocarcinogen now known, croton oil, contains many similar nonpolar-polar compounds, we decided to investigate whether some of our substances would have true cocarcinogenic properties.

The tumor-promoting property of an un-ionic detergent Span 20 (sorbitan monolaurate) was first studied by using Berenblum's technique (*4*). Two-month old male white mice of the same known ("anonymous") strain employed in all our previous studies were used. The animals were divided into three subgroups, 50 mice in each. The skins of the animals in group 1 received a single painting of 0.3 percent 9,10-dimethyl-1,2-benzanthracene dissolved in paraffin oil, but no additional treatment at all. Up to now—that is, 24 wk after the application—no tumors have developed, and all mice are alive. The mice in group 2 were painted twice daily during these 24 wk with pure Span 20; no tumors have developed in this group either. The animals in group 3 received a single painting of 0.3 percent 9,10-dimethyl-1,2-benzanthracene in paraffin oil, and then the same area of the skin of the back was painted twice daily with Span 20. In this group local cutaneous tumors began to appear at the end of the fifth week, and after 24 wk of treatment, 21 of the 50 mice have together 34 tumors. All mice were kept under similar conditions. Precautions were taken to avoid sources of methodical errors.

Large series of this kind of well-defined lipophilic-hydrophilic substances, having cocarcinogenic properties, are now being tested by us. The results available today point in the same positive direction, and a number of the compounds are highly potent cocarcinogens, even stronger than croton oil. Thus, another un-ionic detergent, Tween 60 (polyoxyetheylene sorbitan monostearate), for instance, showed significantly stronger tumor-promoting property than Span 20. When Tween 60 was used as a cocarcinogen in the aforementioned way, more than 70 percent of the animals developed skin tumors in 16 wk. The substances containing longer carbon chains appear to be stronger cocarcinogens. Further, the morphologic alterations seen in the skin of mice painted *only* with the nonpolar-polar compounds vary according to the compound used. In addition, the changes astonishingly closely resemble the alterations that are described as the "early response of the mouse skin to carcinogens." By changing the character of the lipophilic-hydrophilic solution, it was possible to induce alterations of different intensity in both the epidermis and the dermis (*5*).

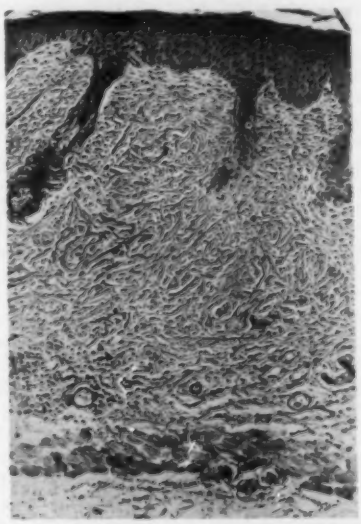

Fig. 1. Skin (right side of the back) of Mouse No. 54 after 2 wk of twice daily painting with Span 20 only. Thickening and distinct alterations in epidermis. Significant changes in dermis, collagenosis, dilated capillaries, and so forth. H + E. (× 85)

The cocarcinogenic power of the individual substance, on the one hand, and the nature as well as the intensity of the morphologic changes that it induced in the skin, on the other hand, seem to be dependent, for example, on the position of the compound in the hydrophile-lipophile balance value series (*6*) when certain un-ionic synthetic detergents were used. The mechanism of the physicochemical and morphologic alterations in the cutaneous structures is now being studied, considering especially the property of nonpolar-polar substances to alter (and degenerate) various proteins as well as the binding of water, which seems to be one of the features of the induced change. In this connection we want to draw attention to the influence (*3*) of nonpolar-polar compounds on proteins, for example, denaturation with resulting liberation of biologically—and possibly also for the tumorigenesis—important —SH— and other groups, changes in solubility, alterations in molecular weight and shape, changes in antigenity and susceptibility to enzymatic digestion as well as changes in x-ray diffraction patterns and infrared absorption spectra. Interesting also is the appearance of fiber formation in various cutaneous structures as a result of treatment with nonpolar-polar compounds (the same phenomenon is well-known from studies *in vitro*).

Our present experiments with these compounds have given us the impression that the histologic changes seen in connection with the "early response of the mouse skin to carcinogens" are, for the most part, only comparatively nonspecific phenomena running parallel to the still unknown process of carcinogenesis, or being merely a reflection of this occurrence. Apparently the processes in the various structures of the skin also run parallel to each other, none being the real cause of the others. By varying the character of the cocarcinogenic nonpolar-polar compound (and thereby the quality and localization of the morphologic and chemical alterations) and the concentration of the carcinogen, it may be possible to induce skin tumors under more strictly controlled conditions than hitherto. In this way we are now trying to investigate which chemical and morphologic alterations are really necessary for the production of experimental skin tumors in mice and what is necessary for the achievement of a cocarcinogenic effect as well as the interaction between the stromal and parenchymal alterations during tumorigenesis.

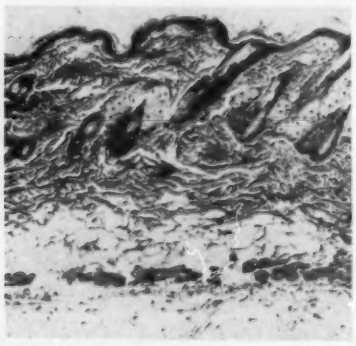

Fig. 2. Skin (left side of the back) of mouse No. 54; no treatment at all. Normal appearance. This specimen was taken at the same time that the specimen in Fig. 1 was taken. H + E. (×85)

The results of the protein-chemical findings, as well as the details of histologic findings, will be reported elsewhere.

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22 June 1954.

Living Out "Future" Experience under Hypnosis

Rubenstein and Newman in their article, "The living out of 'future' experiences under hypnosis" [*Science* **119**, 472 (1954)] raise some issues that may require clarification. In describing a technique that deals with the projections of hypnotic subjects' experiences into a future time, they have presented a clinical modification of a time-progression and fantasy-projection technique recently reported upon by Israeli [*J. Clin. and Exptl. Hypnosis* **2**, 49 (1953)]. Although their report is of considerable interest with respect to personality study and projection in general, the authors do not make it clear that the technique they employed was one of *time* distortion rather than one of *age* alteration. Nevertheless, from their observations, they conclude that, since this type of projection appears to be essentially a fantasy, perhaps hypnotic age regression, too, is a fantasy. In view of the fact that the authors deal with time and not age as a variable within the framework of their hypnotic experiments, it appears dubious that their extension and generalization of findings to include alterations in age variables, particularly age regression, is meaningful.

It must be pointed out that there is a definitive difference between hypnotic *age* "regression" and "progression" and *time* "regression" and "progression." With alterations in time, recent experimental experience indicates that the subject tends to alter his perception of the world around him in the same manner that he does in all basic expressions of projection—that is, in a manner consistent with his inner personality organization. Clinical techniques, such as the

Thematic Apperception Test and the Rorschach Test, deal with elements of the way in which perceptive functions are influenced and altered by inner emotional and ideational forces. With hypnotic techniques of time alteration, the subject tends to reflect no apparent change in body-image, impulse handling, or other major dimensions of personality functioning. On the other hand, with techniques of age regression and progression, there appear to be some alterations in body-image and self-concept, with changes in the organization of expressive behavior related to these primary activities.

The validity of hypnotic age regression lies not in the actuality of reproductive elements of behavior but rather in the perception of the body-image and the *level* and *manner* of behavior organization. Memory variations and simulations take place within valid and nonvalid instances of hypnotic age regression. The difference and, consequently, the validity of the phenomenon of age regression are to be found not in the projective behavior but in the behavior organization processes. The hypnotic technique of "time progression" reported upon by Rubenstein and Newman may be a useful projective technique, but it does not appear to relate directly to the problem of hypnotic age regression or to question its validity.

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Journal of Clinical and Experimental Hypnosis
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22 April 1954.

R. Rubenstein and R. Newman [*Science* **119**, 472 (1954)] discuss their hypothesis of hypnotic age regression. Our pilot study gives experimental support for their viewpoint.

Five deeply somnambulistic subjects were individually hypnotically regressed to two specific past birthdays for each subject. Birthdays that had fallen either on a Saturday or a Sunday—that is, on nonschool days—were chosen by the experimenters. After regression, the subjects were asked to describe the activities of the selected day in order to elicit from them a commitment on whether or not they had attended school on that day. When a subject did not yield the desired information through free description, the experimenters employed a subtle questionnaire to obtain this information. When this information had been obtained, the digit memory span portions of the Stanford Binet test were administered, moving down from the subject's actual age level to his regressed age level. The subjects' regressed ages were from 8 to 15 years; their actual ages were from 21 to 25 years.

At the regressed levels all the subjects responded appropriately on the digit span test, failing levels associated with higher age groups. Four of the subjects incorrectly stated that they attended school on both the weekends involved. The fifth subject also incorrectly described a school day for her 9th (regressed) birthday but correctly identified the day for her 14th birthday. This correct identification was accompanied by a general emotional abreaction and an explanation that her grandfather had just died. A subsequent check with the subject's family verified the date of the death, and the same information was recalled by the subject in a waking state.

The criterions chosen for this study would seem to give the subjects the greatest possible chance to prove age regression. A birthday in itself is usually a memorable experience in a child's life, and its details might be expected to stand out clearly in the "reliving" experience of age regression. The fact that all the birthdays fell on weekends, which alone have high hedonic tone for children, might heighten awareness of the experience. However, none of the subjects could locate themselves in time and were trapped into descriptions of events in school that could not have occurred, the hypothetical event having been on a day when there was no school. Nevertheless, the subjects went on at length in their descriptions of the people present and gifts received on these birthdays. Also all the subjects had "regressed," for they all responded to the digit memory span test at the proper age level. It should also be added that the relatively nonobjective measures of graphology and verbalization level roughly coincided with the "regressed" age. Thus it would seem that, even though the subjects were given the benefit of a very convenient situation, they could not tell on which days of the week their birthdays fell or even that they were on a weekend.

The results of this study tend to indicate that age regression is not true and complete. Subjects cannot return under hypnosis, at the will of the hypnotist, to *any specific* time or place in their personal history. It is our belief that, under the pressure of hypnotic suggestions, subjects have heightened recall of an age *level* of their personal experience rather than of a specific time or place from their history. Although this type of recall may be clinically useful, it is questionable whether it can be defined as age regression. Coupled to this type of recall are the present adult experiences with children of the age to which the adults have regressed. These two types of experience were interwoven in the hypnotic fantasy to present a complete experience that will relieve the subject from the pressures of the suggestion exerted by the hypnotist.

Our conclusions are presented as corroboration for the hypotheses expressed by Rubenstein and Newman. A criticism that may be leveled at their report, as well as ours, is the unreliability of the information contained in a sample of five cases. Certainly one would be hesitant to place much statistical validity on the data presented. It is hoped, however, that further research may be undertaken to place the problem of age regression in a more realistic perspective than heretofore held in psychological thinking.

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7 May 1954.

Symbols for Units of Measurement

Since the symbols—names, or their abbreviations—for physical units may be incorporated in physical equations in exactly the same manner as are the letter symbols for physical quantities and the numerical symbols, it follows that the rules for selecting and using these unit-symbols should be formulated in the light of established mathematical procedures. [See editorial page of this issue.]

A number of the symbols listed in Table 1 do not conform with the following rules but are so firmly established that attempts to change them would be futile. Exceptions to rules of language are a common occurrence and provide no good argument against having rules that facilitate a choice between several well-established symbols or the selection of a symbol for a new unit.

1) *The symbol preferably should consist of two or three letters, and never more than four.* Thus "lu" is preferable to "l" for "lumen." Well-established exceptions to this rule include "gamma" for "gamma," "j" for "joule," and "v" for "volt." If the name of a unit contains only two or three letters, this name, rather than an abbreviation, should be used; examples are "bar," "day," "erg," "lux," and "ohm."

2) *The symbol preferably should consist of the first two or three letters of the name of the unit.* This facilitates recognition and pronunciation, as in "dy" for "dyne," "lu" for "lumen," and "oer" for "oersted." Among the firmly established exceptions to this rule are "et," "ft," "hr," "hy," "lb," and "oz."

3) *Preferably there should be only one symbol for a particular unit.* However, it seems desirable to recommend certain exceptions; for example, both "a" and "amp" for "ampere," and "b" and "bel" for "bel," the "a" and "b" to be used only with combining forms, as in "ma" and "db."

As the rule implies, the same symbol should be used for both singular and plural forms; thus, 10 amp, *not* 10 amps.

One of several objections to such symbols for secondary (derived) units as "fps" and "rpm" is that the "f," "s," "r," and "m" are used in place of the well-established "ft," "sec," "rev," and "min."

4) *Periods should be omitted from symbols.* An exception is "in.," for "inch," since omission of the period would often result in confusion.

5) *The symbol for a combining form denoting a multiple or submultiple should be a single letter.* Thus "μ" for "micro-," "M" for "mega-," and so on.

Use of Unit Symbols in Printed Text

1) *Set the symbol for a unit in roman type.*

2) *Use an abbreviated unit-symbol only when it:* (i) *is preceded by a numerical value, or* (ii) *appears in headings of tables or in crowded text, in which cases the symbol is enclosed in parentheses.* Thus: "25 cm"; "several centimeters"; "volumes, in cubic centimeters"; "volumes (cm^3)"; "v (cm^3)."

3) *Use standard signs to indicate all mathematical operations with unit symbols.* Thus indicate: (i) multiplication by a space, a center dot, or even ×; (ii) division by a solidus, a negative exponent, or the ordinary fractional form; (iii) a power by a positive exponent; (iv) a root by a fractional exponent or √. Thus dy cm, dy · cm, or even dy × cm, but *not* dy-cm; ft/sec, ft sec^{-1}, or $\frac{ft}{sec}$, *not* fps, fs, or (in equations) ft per sec; cm^3, *not* cu cm or cc.

A hyphen should not be used to indicate multiplication, or a "p" to indicate division, since these devices are not used elsewhere in mathematics for these purposes. A hyphen should be used only when it is desired to separate parts of a single unit symbol; thus a hyphen is appropriately used in "ft-ca," since the "foot-candle" does not represent the product of "foot" and "candle."

It is not uncommon to see abbreviations such as the following used for secondary units: cfm (*for* ft^3/min); kgps (*for* kg/sec); mphps (*for* mi/hr sec); psf (*for* lb/ft^2); rpm (*for* rev/min). A form such as "rpm" may be used on crowded diagrams or apparatus labels; but from the standpoint of suitability for substitution in physical equations and ease of mathematical manipulation, the afore-mentioned forms are comparable to such unconventional and ambiguous algebraic expressions as: cab (for a^2/b); apb (for a/b); $apbpc$ (for a/bc); asb for (a/b^2); and so on. Of course, forms such as "cfm" or "mphps" may be regarded merely as special names for secondary units, in the sense that "dyne" and "erg" are names for such units. But the suggestion that special names, many of them unpronounceable, be given to all commonly used secondary units, metric and English, multiple and submultiple, is certainly not a move in the direction of greater economy of thought and learning.—D. R.

Table 1. Proposed symbols for units.

Unit or combining form	Symbol	Examples of use; comments
ab-	ab	abamp, abcoul/cm^2
acre	acre	acre ft
ampere	amp	amp turn/m
	a	With prefixes: ma, μa
angstrom	A	
are [$\equiv 10^2$ m^2]	are	Use sparingly
atom	atom	atom/gm-awu, atom/mole
atomic mass unit	amu	1 amu=931 Mev
atomic weight unit	awu	1 awu=1.0002 amu
atmosphere, standard	atm, A_s	
atmosphere at 45°	atm_{45}, A_{45}	
bar [$\equiv 10^6$ dy/cm^2]	bar	
barn [$\equiv 10^{-24}$ cm^2]	barn	
barrel	bbl	
barye [$\equiv$dy/cm^2]	...	Use μbar or dy/cm^2
bel	bel	
	b	With prefixes: db

Unit or combining form	Symbol	Examples of use; comments
billion [$\equiv 10^9$ or 10^{12}]	...	Ambiguous; deprecated
Bohr magneton, electronic	μ_e	$1\ \mu_e = 9.27 \times 10^{-21}$ erg/gauss
Bohr magneton, nuclear	μ_I	$1\ \mu_I = \mu_e/1836$ erg/gauss
Brinell hardness number	Bhn	
British thermal unit	Btu	Btu/lb F°
bushel	bu	bu/acre
calory	cal	
Calory	...	*See* kilocalory
candle	ca	ca hr, ca/m²
candlepower	...	*See* candle
Celsius degree (*temp. difference*)	C°	cal/cm sec C° 100C° ≡ 180F°
Celsius temperature		*See* degree Celsius
cent (*acous.*)	cent	
cent (*monetary*)	ct	ct/gal, ct/kw hr
	¢	In crowded tables, etc.
centi- [$\equiv 10^{-2}$]	c	cm
centigrade	...	*See* Celsius
centimeter-gram-second unit	cgsu	Use sparingly
centimeter-of-mercury	cm-hg	
centimeter-of-oil	cm-oil	
cgs electromagnetic unit	cgsm	*See also* ab-
cgs electrostatic unit	cgse	*See also* stat-
circular (*adj.*)	cir	cir-mil [$\equiv 0.7854$ mil²]
coulomb	coul	coul/m³
count	count	count/min
cubic	³	cm³ (never "cc"), ft³/sec
curie	c	mc, μc
cycle	cy	cy/sec [≡hz]
	c	Often used with prefixes: kc, Mc
day	day	
deca- [≡10]	...	Deprecated
deci- [$\equiv 10^{-1}$]	d	db, dm
degree (*of arc*)	deg	deg/sec (*ang. velocity*)
	°	90°
degree absolute	...	*See*: degree Kelvin; degree Rankine
degree Baumé	°B	
degree Celsius	°C	0°C ≡ 32°F
degree Fahrenheit	°F	32.000°F (*ice point*)
degree Kelvin	°K	276.16°K
degree Rankine	°R	491.69°R
deka- [≡10]	...	Deprecated
diopter	diop	
division	div	div/sec, div/μv
dollar	dol	dol/hr, dol/ton
	$	In tables, etc.
dozen	doz	doz/hr
dyne	dyn	dy/cm², dy cm (*torque*)
electromagnetic unit	emu	Ambiguous: deprecated
electron (*charge*)	e	
electron volt	ev	$1\ \text{ev} = 1.601 \times 10^{-12}$ erg
electrostatic unit	esu	Ambiguous; deprecated
erg	erg	erg sec, erg/C°, erg/deg
Fahrenheit degree (*temp. difference*)	F°	Btu/F°
farad	fd	fd/m
	f	With prefixes: abf; μf
foot	ft	ft/sec²
foot-candle [≡lu/ft²]	ft-ca	lu/ft² is preferable
foot-lambert [≡ca/π ft²]	ft-lam	
foot-pound-second unit	fpsu	Use sparingly
fresnel [$\equiv 10^{12}$ cy/sec]	fr	
gallon	gal	gal/min
gamma [10^{-5} oer]	gamma	
gamma [≡μg]	...	Deprecated; use microgram, μg
gauss	gauss	
geepound	...	Synonym for slug
giga- [$\equiv 10^9$]	G	Gev
gilbert	gil	
gill	gill	
grad [$\equiv 10^{-2}$ rt. angle]	grad	
grain	gr	
gram	gm	
	g	With prefixes: kg; mg
gram atomic weight	gm-awu	
gram calory	...	*See* calory
gram molecular weight	...	*See* mole
grav [≡32.174 ft/sec²]	grav	
Hartree unit	hu	
hecto-, hect- [$\equiv 10^2$]	h	Use sparingly: hm
hekto-	...	Variant of hecto-
henry	hy	hy/m
	h	With prefixes: mh
hertz [≡cy/sec]	hz	hz sec [≡cy]
horsepower	hp	hp hr
hour	hr	hr/day
	h	Astron. text and tables: 3^h
inch	in.	in./sec
inch-of-mercury	in.-hg	
inch-of-oil	in.-oil	
joule	j	j/mole deg
Kelvin degree (*temp. difference*)	K°	
	deg	Use when not ambiguous: erg/deg molecule
kilo- [$\equiv 10^3$]	k	kcal, kev, kmole
kilogram-calory	...	*See* kilocalory
kilocalory	kcal	
kilogram-mole	...	*See* kilomole
kilomega- [$\equiv 10^9$]	kM	*Also see* giga-
kilomole	kmole	
knot	knot, kn	knot hr, kn hr
lambert [≡ca/π cm²]	lam	
large calory	...	*See* kilocalory
light-year	lt-yr	
line	line	line/cm²

Unit or combining form	Symbol	Examples of use; comments
liter	lit	
	l	With prefixes: ml, k
lumen	lu	lu hr, lu/watt
lux [≡lu/m²]	lux	lux sec
magnetic pole	. . .	*See* pole
magneton	. . .	*See* Bohr magneton
maxwell	max	
mega-, meg- [≡10^6]	M	Mev, Mm
megamega- [≡10^{12}]	. . .	*See* tera-
megohm [≡10^6 ohm]	meg, Mohm	meg/m, Mohm/m
meter	m	
meter-candle [≡lux]	m-ca	lux is preferable
meter-kilogram-second unit	mksu	Use sparingly
mho	mho	mho/cm
micro-, micr- [≡10^{-6}]	μ	μsec, μv, μg
micrometer	. . .	*See* micron
micromicro- [≡10^{-12}]	. . .	*See* pico-
micron [≡10^{-6} m]	μm, μ	
mil [≡10^{-3} in.]	mil	
mile	mi	mi/gal
mil-foot	mil-ft	ohm/mil-ft
milli- [≡10^{-3}]	m	ma, ml (not "cc")
millimicro- [≡10^{-9}]	. . .	*See* nano-
millimicron [≡10^{-9} m]	mμ	
million [≡10^6]	M	Mgal/day; *see* mega-
minute (*of arc*)	min	min/sec (*ang. velocity*)
	′	In tables, etc.
minute (*of time*)	min	
	m	Astron. text and tables: 5^m
mks electromagnetic unit	mksm	
mole	mole	
molecule	molecule	
month	mo	
myria- [≡10^4]	myria	Use sparingly
nano- [≡10^{-9}]	n	
neper [≡8.686 db]	nep	
newton [≡kg m/sec²]	new	new/m²
normal atmosphere	. . .	*See* atmosphere, standard
number	no.	no./hr
ohm	ohm	ohm cm
	Ω	In crowded diagrams, etc.
oersted	oer	
ounce	oz	
phon	phon	
phot [≡lu/cm²]	phot, ph	
pico- [≡10^{-12}]	p	
pint	pt	
pole, unit magnetic	pole	dy/pole
poise [≡dy sec/cm²]	poise	
pound	lb	
pound		
poundal	pdl	ft pdl
pulse	pulse	pulse/sec
quart	qt	
radian	rad	rad/sec
Rankine degree (*temp. difference*)	R°	Btu/lb R°
revolution	rev	rev/min, rev/sec ("rpm" and "rps" only in crowded tables, etc.)
rhe [≡1/poise]	rhe	
rod	rod	
roentgen	r	mr
rowland	row	
r-unit	. . .	Synonym for roentgen
rutherford	rd	
second (*of arc*)	sec	
	″	In tables, etc.
second (*of time*)	sec	
	s	Astron. text and tables: 10^s
slug [≡32.174 lbm]	slug	slug/ft³ (*density*)
Siegbahn unit	. . .	Synonym for x-unit
small calory	. . .	*See* calory
square	²	in.²
stat-	stat	statamp, statcoul
steradian	srad	
stilb [≡cd/cm²]	. . .	Deprecated; use cd/cm²
tera- [≡10^{12}]	T	
thousand [≡10^3]	k	kBtu, kft
ton	ton	
turn	turn	
vibration	vib	vib/sec
volt	v, volt	v coul, volt coul
watt	watt	watt hr
	w	With prefixes: kw
weber	web	web/m²
x-unit	xu	1 xu=1.0020 mA
week	wk	
yard	yd	
year	yr	

. . . the French Empire recognized Davy's work in electrolysis which had been the subject of the Bakerian lecture for 1806. While the two nations were at war, he went to Paris and received a medal which Napoleon Bonaparte had established for the Institute to award for "the best experiment which should be made in the course of each year on the galvanic fluid."—G. A. Foote, *Isis* **42**, *205 (1951)*.

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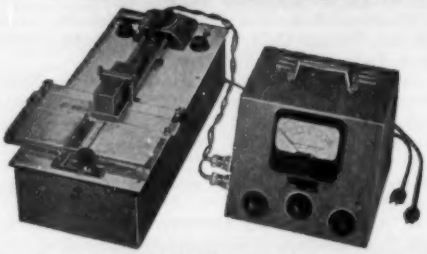

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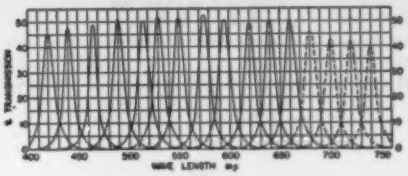

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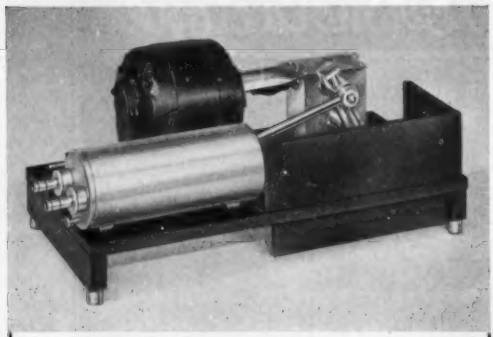

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Meetings & Conferences

January

26–2. Australian and New Zealand Assoc. for the Advancement of Science, Melbourne, Australia. (J. R. A. McMillan, 157 Gloucester St., Sydney.)

27. American Federation for Clinical Research, western section, Carmel, Calif. (A. B. French, College of Medicine, Univ. of Utah, Salt Lake City.)

27–28. Symposium on Hydrocarbon Chemistry, Houston, Texas. (L. B. Odell, Rice Hotel, P. O. Box 38, Houston.)

27–29. American Physical Soc. New York, N.Y. (K. K. Darrow, Columbia Univ., New York 27.)

27–29. American Assoc. of Physics Teachers, annual, New York, N.Y. (R. F. Paton, Univ. of Illinois, Urbana.)

28–29. Assoc. of Geology Teachers, annual, Columbus, O. (R. P. Goldthwait, Ohio State Univ., Columbus 10.)

28–29. Bur. of Biological Research, Rutgers Univ., New Brunswick, N.J. (W. H. Cole, College of Arts and Sciences, Rutgers Univ., New Brunswick.)

February

4–5. American Geophysical Union, Berkeley, Calif. (D. K. Todd, College of Engineering, Univ. of California, Berkeley 4.)

7–9. Conf. on Silicosis and Occupational Chest Diseases, Saranac Lake, N.Y. (N. R. Sturgis, Jr., Saranac Laboratory, Saranac Lake.)

7–11. American Soc. of Civil Engineers, San Diego, Calif. (W. N. Carey, 33 W. 39 St., New York 18.)

8–9. Midwest Welding Conf., Illinois Institute of Technology, Chicago. (Mel Garbar, Illinois Institute of Technology, 35 W. 33rd St., Chicago 16.)

11–25. Pan American Acad. of General Practice, Lima, Peru. (A. Martinez, 54 E. 72 St., New York 21.)

13–17. American Inst. of Mining and Metallurgical Engineers, annual, Chicago, Ill. (E. H. Robie, 29 W. 39 St., New York 18.)

14–16. Nutrition of Plants, Animals, Man. Michigan State College, Centennial Symposium, East Lansing. (Continuing Education Service, Kellogg Center, Michigan State College.)

14–19. Latin American Cong. of Physical Medicine, Lima, Peru. (C. L. de Victoria, 176 E. 71 St., New York 21.)

17–18. National Conf. on Transitor Circuits, Philadelphia, Pa. (W. J. Popowski, Minneapolis-Honeywell Regulator Co., 176 W. Loudon St., Philadelphia 20.)

17–19. American Acad. of Forensic Sciences, Los Angeles, Calif. (W. J. R. Camp, 1853 Polk St., Chicago 12, Ill.)

28–1. American Orthopsychiatric Assoc., 32nd annual, Chicago, Ill. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

28–2. American Educational Research Assoc., St. Louis, Mo. (F. W. Hubbard, 1201 16 St., NW, Washington 6, D.C.)

March

2–4. American Assoc. of University Professors, Gatlinburg, Tenn. (R. E. Himstead, AAUP, 1785 Massachusetts Ave., NW, Washington 6, D.C.)

7–9. Chemical Inst. of Canada, Divisional Conf. of the Chemical Engineering Div., Ottawa, Ont. (W. M. Campbell, Box 323, Deep River, Ont.)

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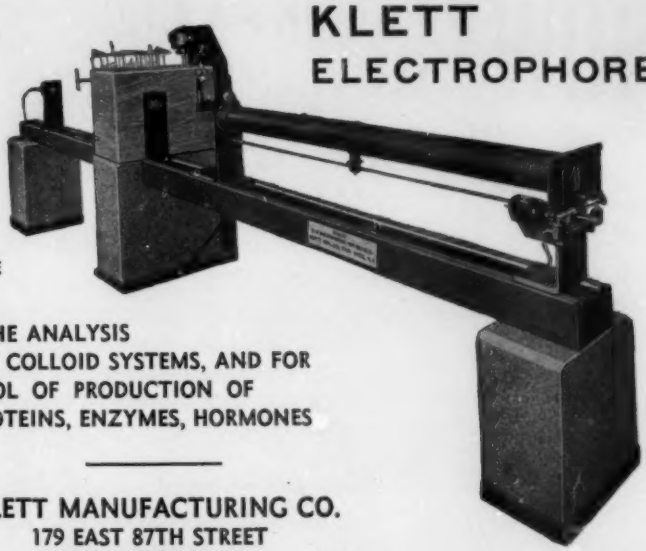

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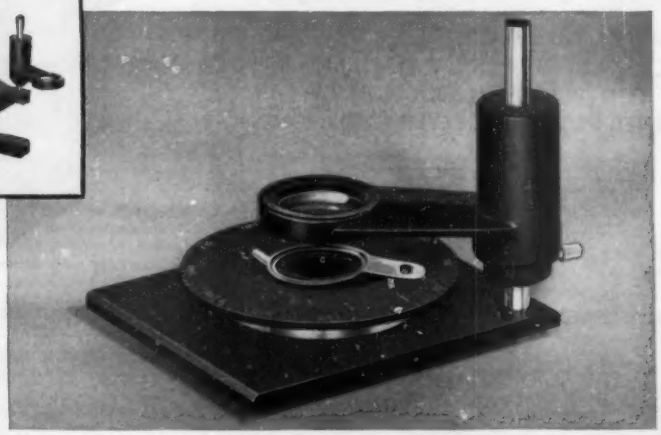

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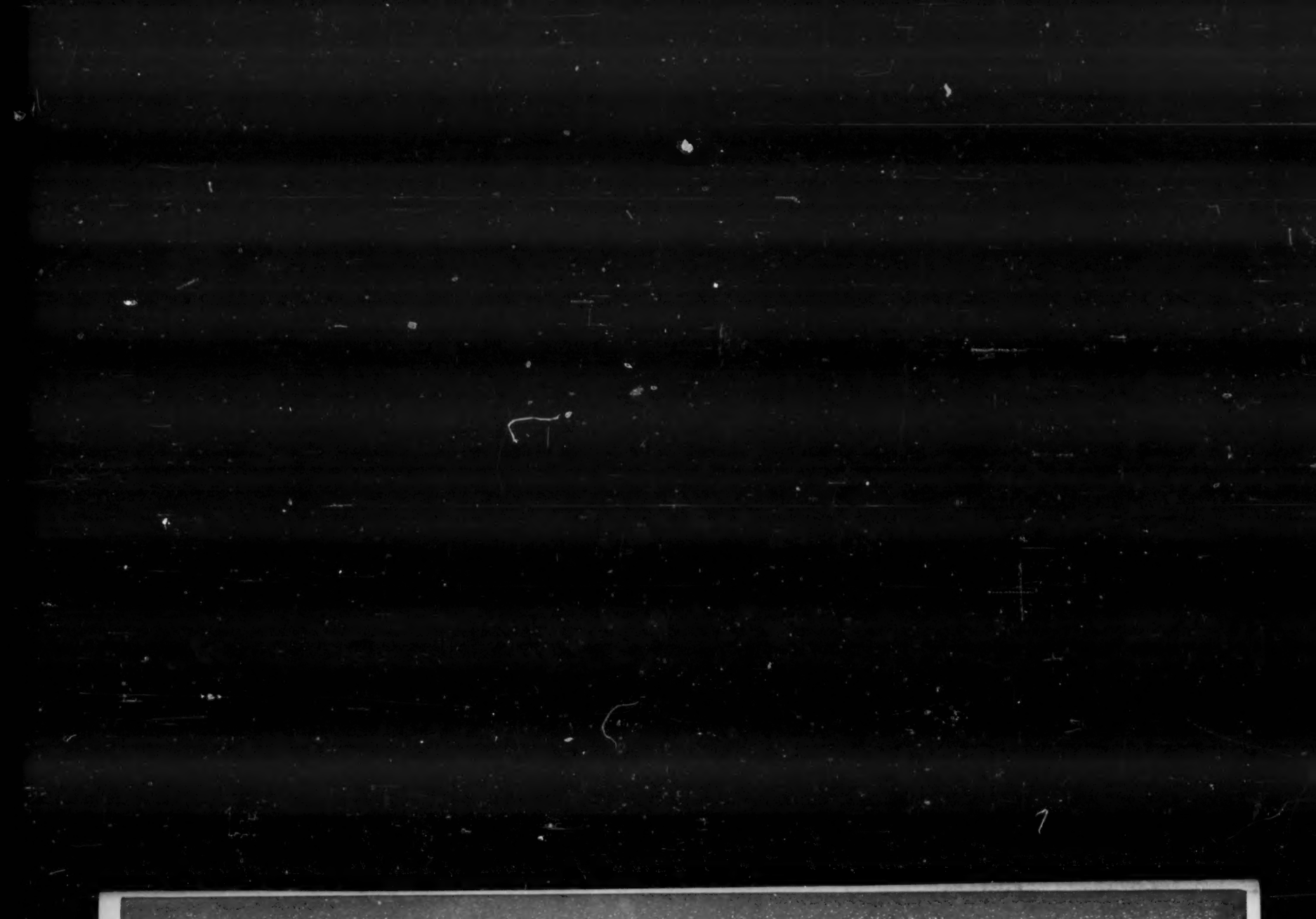
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